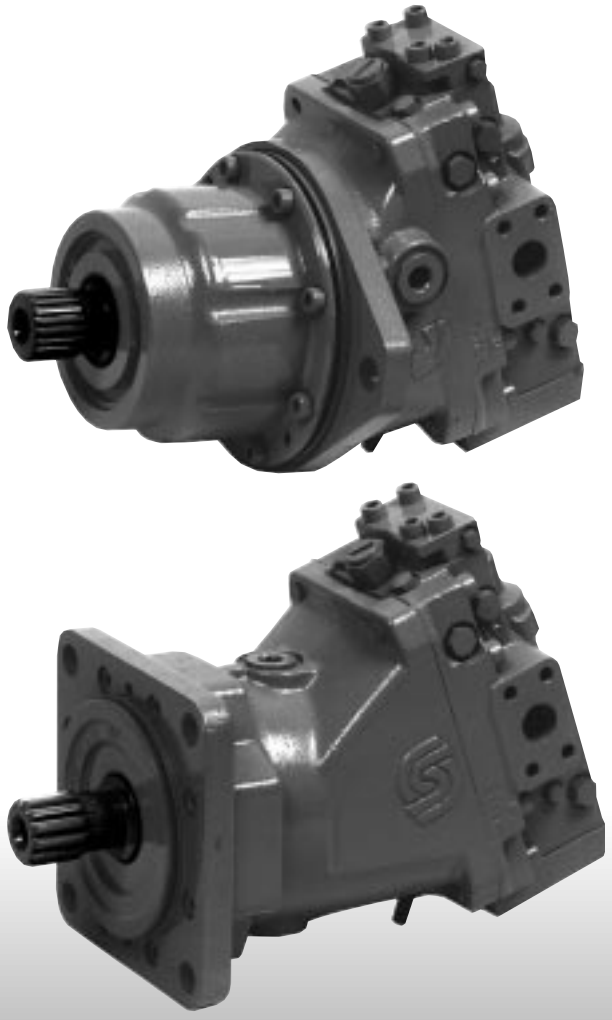
SAUER SUNDSTRAND

Series 51



Bent Axis
Variable Motors
Service Manual

Bent Axis Variable Displacement Motors Series 51

General Description

Series 51 Variable Displacement Motors are bent axis design units, incorporating spherical pistons.

These motors are designed primarily to be combined with other products in closed circuit systems to transfer and control hydraulic power.

Series 51 Motors have a large maximum / minimum displacement ratio (5 to 1) and high output speed capabilities. SAE flange and cartridge motor configurations are available.

A complete family of controls and regulators is available to fulfill the requirements of a wide range of applications.

Motors equipped with controls normally start at maximum displacement. This provides maximum starting torque (high acceleration).

The controls may utilize externally or internally supplied servo pressure. They may be overridden by a pressure compensator which functions when the motor is operating in motor and pump modes. A defeat option is available to disable the pressure compensator override when the motor is running in pump mode.

The pressure compensator option features a low pressure rise (short ramp) to provide optimal power utilization throughout the entire displacement range of the motor. The pressure compensator is also available as a stand-alone regulator.

- **The Series 51 - Advanced Technology Today**
- **The Most Technically Advanced Hydraulic Units in the Industry**
- **SAE Flange and Cartridge Motors**
- **Cartridge Motors designed for Direct Installation in Compact Planetary Drives**
- **Large Displacement Ratio (5:1)**
- **Complete Family of Control Systems**
- **Proven Reliability and Performance**
- **Optimum Product Configurations**
- **Compact, Lightweight**

Front page: Option - hydraulic two-position control

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Introduction

The purpose of this manual is to provide information necessary for the normal servicing of the Series 51 family of variable displacement hydrostatic motors.

This manual includes unit and component description, troubleshooting, adjustments, and minor repair procedures. By following the procedures in this manual, inspections and minor repairs may be performed without affecting the unit warranty.

A Series 51 motor does occasionally require servicing, and these units are designed to meet this requirement.

Many repairs or adjustments can be completed without removing the unit from the vehicle or machine, provided the unit is accessible and can be thoroughly cleaned before beginning any procedures.

Dirt or contamination is the greatest enemy of any type of hydraulic equipment. The greatest possible cleanliness is necessary when starting up the system, changing filters, or performing any other service procedure.

For Technical Information on Series 51 motors, refer to publication BLN-10042 or 368753.

For Fluid Quality Requirements, refer to publication BLN-9987 or 697581.

Sauer-Sundstrand provides a complete repair service for its products. Contact any Sauer-Sundstrand Authorized Service Center for details. Sauer-Sundstrand Authorized Service Center locations are listed in publication BLN-2-40527 or 698266.

Basic Hydraulic Circuits

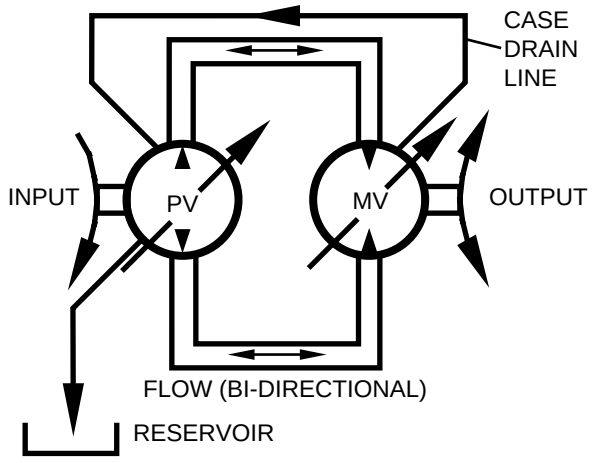

Fig. 0-1 - Basic Closed Circuit

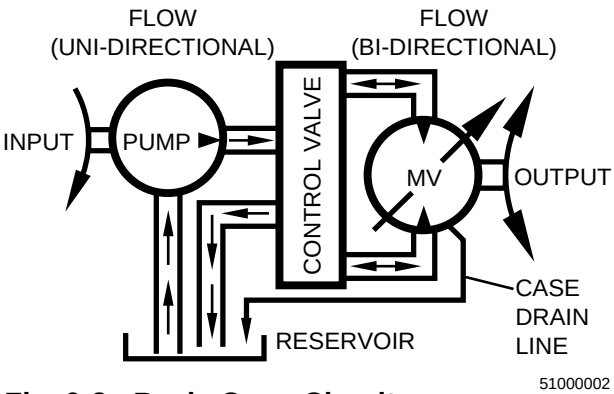

Fig. 0-2 - Basic Open Circuit

Closed Circuit

The main ports of the pump are connected by hydraulic lines to the main ports of the motor. Fluid flows in either direction from the pump to the motor then back to the pump in this closed circuit. Either of the hydraulic lines can be under high pressure. The direction and speed of fluid flow (and the motor output shaft rotation) depends on the position of the pump swashplate. The system pressure is determined by the machine load.

Open Circuit

The outlet port of the pump is connected by a hydraulic line to a directional control valve. The working ports of this valve are connected to the main ports of the motor. When the valve is actuated, fluid flows first from the pump to the valve. The valve then directs the fluid to the motor in either direction. The direction of fluid flow (and motor output shaft rotation) depends on the direction the control valve is shifted. The speed of fluid flow (and motor output shaft speed) depends on pump output volume and the distance the control valve is shifted. The system pressure is determined by the machine load.

Fluid returning from the motor is routed through the control valve to the reservoir. Additional components may be necessary to provide dynamic braking and to deal with over-running loads.

General Description of the Series 51 Variable Displacement Motors

The Series 51 variable displacement hydraulic motors use spherical pistons and piston rings. The angle between the cylinder block and the output shaft can be set between 32° and 6°, providing a 5 to 1 maximum to minimum displacement ratio.

At maximum displacement, the motor will provide a certain maximum output shaft torque and minimum speed corresponding to the pressure and flow supplied to the motor. Under the same input conditions but at minimum displacement, the shaft speed will be approximately five (5) times faster while the available output torque will decrease to approximately one-fifth (1/5) the full displacement value. The displacement is changed by a servo piston which is connected to the valve segment.

Various hydraulic and electrohydraulic controls may be mounted on the motor end cap to control the servo piston and the motor displacement. Servo pressure oil may either be supplied internally from the motor, or externally.

For all controls except the N2 and PC, servo pressure oil is supplied to a four (4) way spool valve in the motor end cap. When a combination of pilot pressure (or force) from an external control assembly and internal spring force shifts this valve, servo pressure is routed to move the servo piston and change the motor's displacement.

A synchronizing shaft, with spherical rollers, synchronizes the rotation of the output shaft and the cylinder block. The ball end of each piston runs in a socket bushing, pressed into the output shaft. There are no other parts used to connect the pistons to the shaft. Two tapered roller bearings support the output shaft.

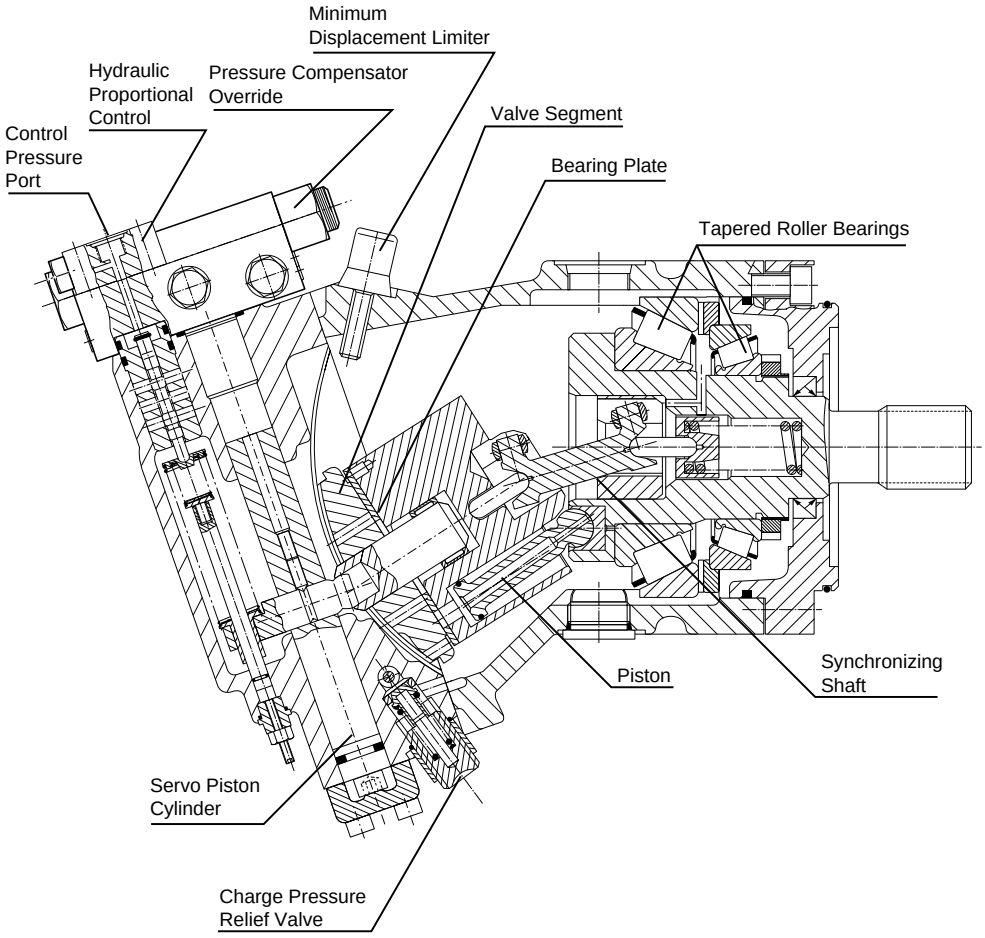

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Fig. 10-1 - Sectional view of Series 51 variable displacement motor (SAE Flange Configuration) with Hydraulic Proportional Control

Functional Description

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Fig. 10-2 - Loop Flushing Components

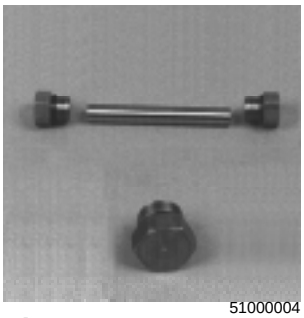
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Fig. 10-3 - Loop Flushing Defeat Components

Loop Flushing

Series 51 motors used in closed circuit applications incorporate an integral loop flushing valve as standard equipment. Installations that require additional fluid to be removed from the main hydraulic circuit because of fluid cooling requirements, or circuits requiring the removal of excessive contamination from the high pressure circuit, can benefit from loop flushing. Series 51 motors used in open circuit applications may have the optional loop flushing defeat components installed.

Series 51 motors equipped with an integral loop flushing valve also include a charge pressure relief valve. The setting of the motor charge relief valve affects the function of the flushing circuit. Higher motor charge relief settings reduce the loop flushing flow and increase the flow over the pump charge pressure relief valve when the circuit is operating. Lower motor charge relief settings increase the loop flushing flow and may increase the motor case pressure when the circuit is operating.

An appropriate combination of pump and motor charge pressure settings should be maintained to insure the proper function of the loop flushing circuit. Correct charge pressure must be maintained under all conditions of operation to maintain pump control performance in closed loop systems.

NOTE: An optional orifice may be installed between the motor charge relief and the motor case to limit the maximum flushing oil flow.

Functional Description (Continued)

Displacement Limiters

All Series 51 motors incorporate mechanical displacement limiters. The minimum displacement of the motor can be limited within the standard range by a set screw in the motor housing. The maximum displacement can be limited with spacers installed on the servo piston.

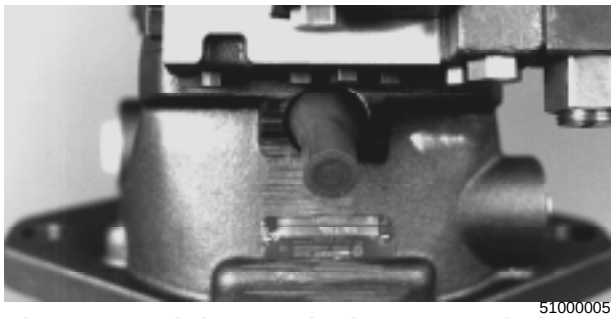

Fig. 10-4 - Minimum Displacement Limiter with Tamper Resistant Cap (Cartridge Motor Configuration Shown)

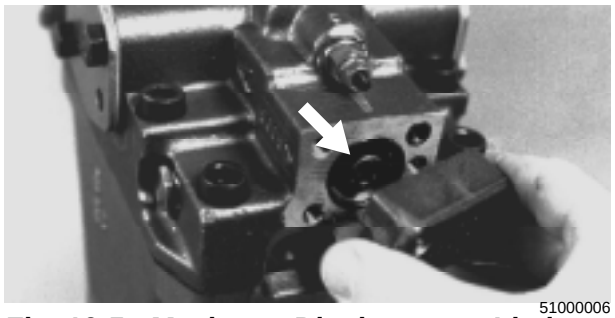

Fig. 10-5 - Maximum Displacement Limiter Screw

Controls - General

A wide range of control options is available for the Series 51 motors. These include pilot operated Electrohydraulic 2-Position Controls, Hydraulic Proportional Controls (single or two [2] connection), and Electrohydraulic Proportional Controls. A directly operated Hydraulic 2-Position Control and a Pressure Compensator regulator are also available.

The Series 51 variable motor servo piston (except when equipped with N2 control or the PC regulator) may be operated either by servo pressure oil supplied internally from the main ports of the motor, or by servo pressure oil supplied from an external source. (The N2 control uses servo pressure supplied by an external control valve. The PC regulator obtains servo pressure from the main ports of the motor.)

Orifice plugs are installed in the control spool sleeve in the end cap to regulate the flow of oil from the servo piston to the motor housing. Orifice plugs may be installed in the end cap to regulate the flow of servo pressure supply oil to the control valve, and to regulate the flow of oil from the control valve to the servo piston.

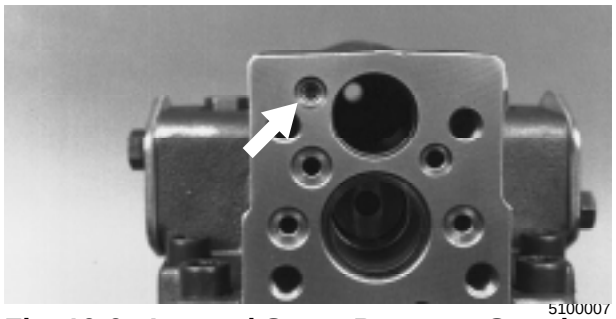

Fig. 10-6 - Internal Servo Pressure Supply Screen with Multi-function Block and/or Control Removed (Plug for External Supply)

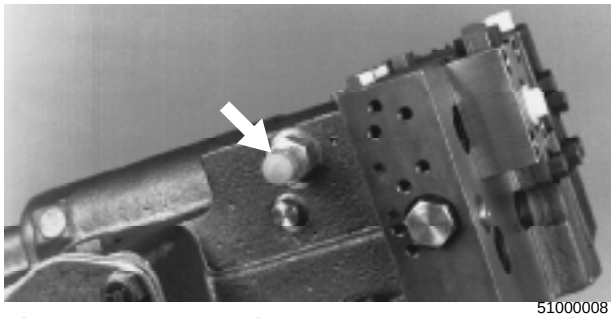

Fig. 10-7 - External Servo Pressure Supply Fitting (Plug for Internal Supply)

Functional Description (Continued)

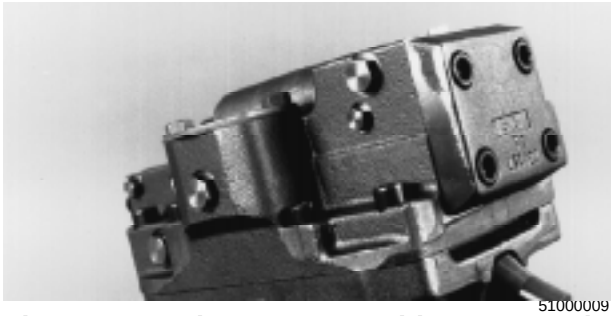

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Fig. 10-8 - Series 51 Motor with N2 Control

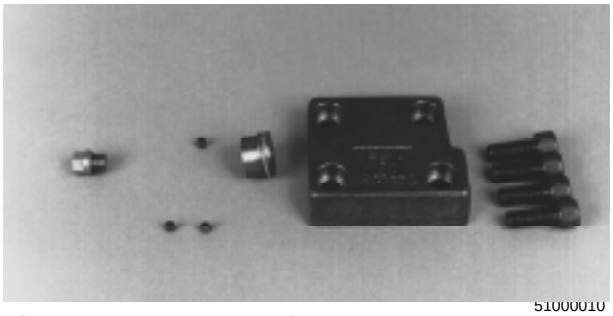

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Fig. 10-9 - N2 Control Components

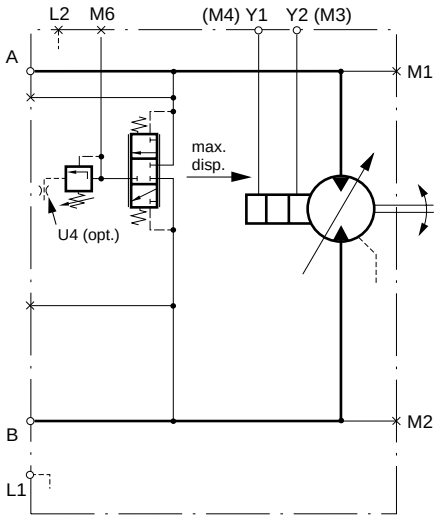

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Fig. 10-10 - N2 Control Schematic

Hydraulic 2-Position Control (Type N2)

This is a two (2) position (maximum - minimum displacement) control, consisting of a cover plate mounted on the end cap. An external control valve supplies servo pressure from an external source directly to the servo piston. PCOR is not available with the N2 control.

When servo pressure is supplied to port “Y1,” the setting piston moves to the maximum motor displacement position. When servo pressure is supplied to port “Y2,” the setting piston moves to the minimum motor displacement position.

Orifices may be installed in the external control valve or its connections to regulate the speed of servo piston movement.

Functional Description (Continued)

Electrohydraulic 2-Position Control (Types E1•E2 and F1•F2)

A 12 or 24 VDC solenoid valve, mounted on the multi-function block, connects the end of the control valve spool in the end cap with pilot pressure (provided by the shuttle spool in the multi-function block) or with the motor case. The control valve in the end cap is biased by a threshold spring, and controls oil flow to the ends of the servo piston. Servo pressure may be supplied from an external source or internally by the shuttle spool in the multi-function block. PCOR is available with these controls.

With the E1 and E2 controls, energizing the solenoid will cause the motor to shift to minimum displacement. When the solenoid is not energized, the motor is held at maximum displacement.

With the F1 and F2 controls, energizing the solenoid causes the motor to shift to maximum displacement. When the solenoid is not energized, the motor is held at minimum displacement.

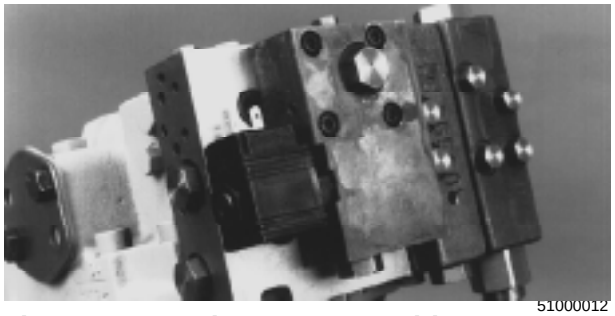

Fig. 10-11 - Series 51 Motor with E1•E2 or F1•F2 Control

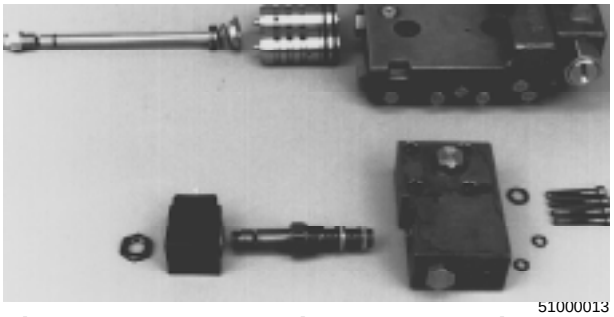

Fig. 10-12 - E1•E2 and F1•F2 Control Components

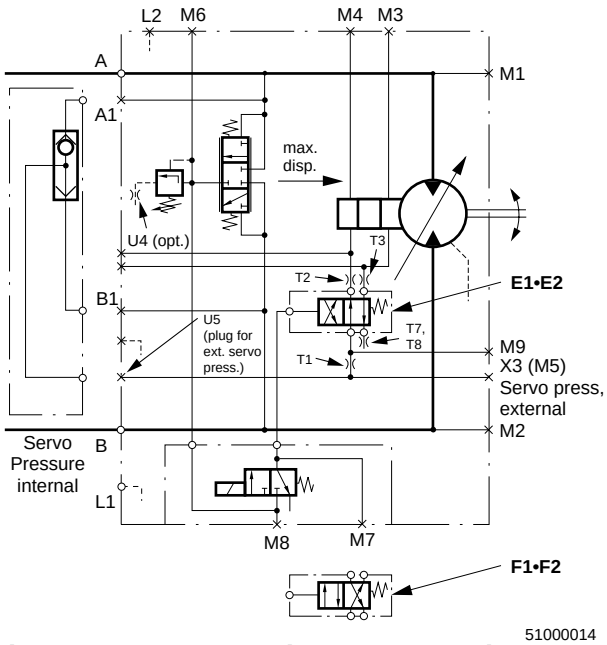

Fig. 10-13 - E1•E2 and F1•F2 Control Schematic

Functional Description (Continued)

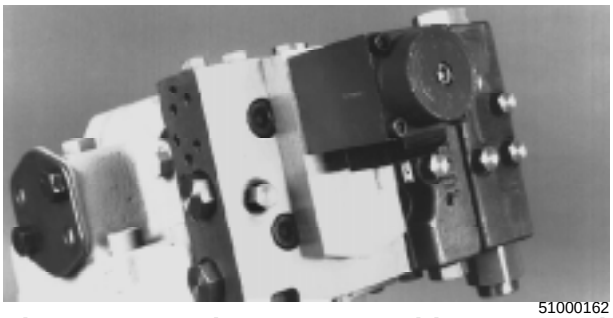

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Fig. 10-14 - Series 51 Motor with S1 Control

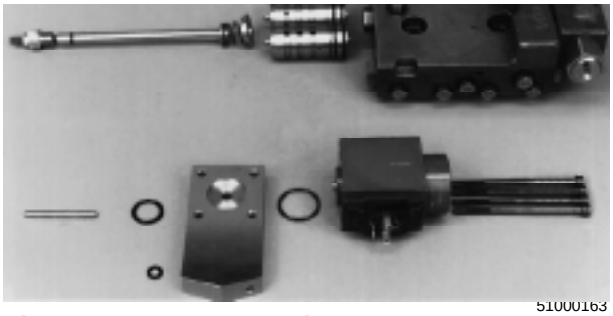

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Fig. 10-15 - S1 Control Components

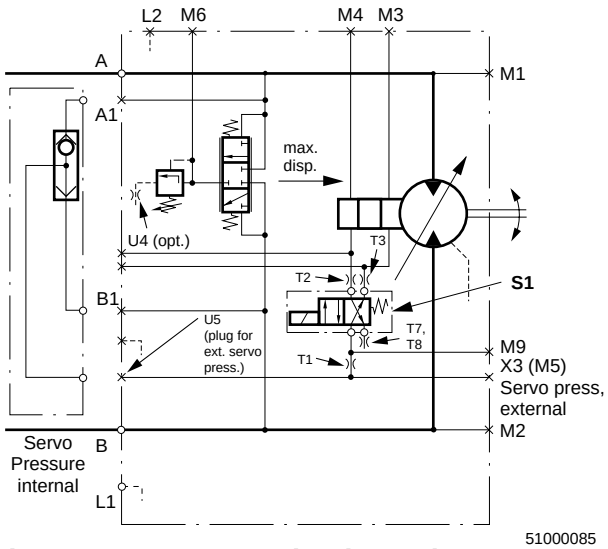

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Fig. 10-16 - S1 Control Schematic

Electric 2-Position Control (Type S1)

A 12 VDC solenoid valve, mounted on the multi-function block, directly operates the control valve spool in the end cap. The control valve in the end cap is biased by a threshold spring, and controls oil flow to the ends of the servo piston. Servo pressure may be supplied from an external source or internally by the shuttle spool in the multi-function block. PCOR is available with this control.

With the S1 control, energizing the solenoid causes the motor to shift to maximum displacement. When the solenoid is not energized, the motor is held at minimum displacement.

Functional Description (Continued)

Hydraulic Proportional Control (Type HZ)

The HZ control consists of a cover plate mounted directly on the end cap. A ball type shuttle valve provides internal servo pressure supply to the control valve in the end cap. PCOR is not available with the HZ control.

Feedback springs (single spring for 060, 080 and 110) and a threshold spring are installed in the end cap. The feedback springs and threshold spring provide a force on the end of the control spool. The force of the threshold spring is externally adjustable with an adjusting screw. The feedback spring is positioned between the control spool and a feedback lug attached to the servo piston. The force of the feedback spring increases as the motor's displacement decreases.

Pilot oil pressure from an external source is applied to the end of the control spool opposite the feedback and threshold springs. An increase in pilot pressure (above the threshold pressure and within the modulating pressure range) will result in a decrease in motor displacement, while a decrease in pilot pressure will result in an increase in motor displacement.

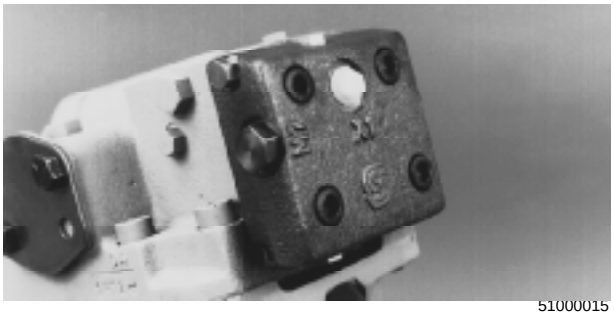

Fig. 10-17 - Series 51 Motor with HZ Control

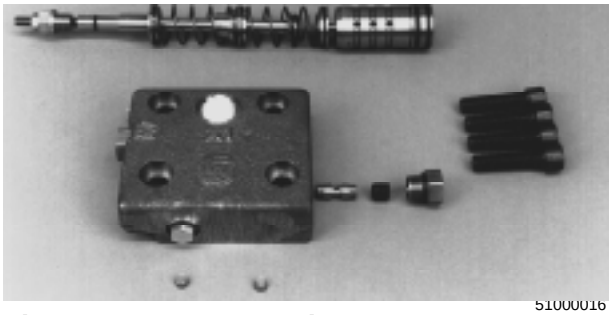

Fig. 10-18 - HZ Control Components

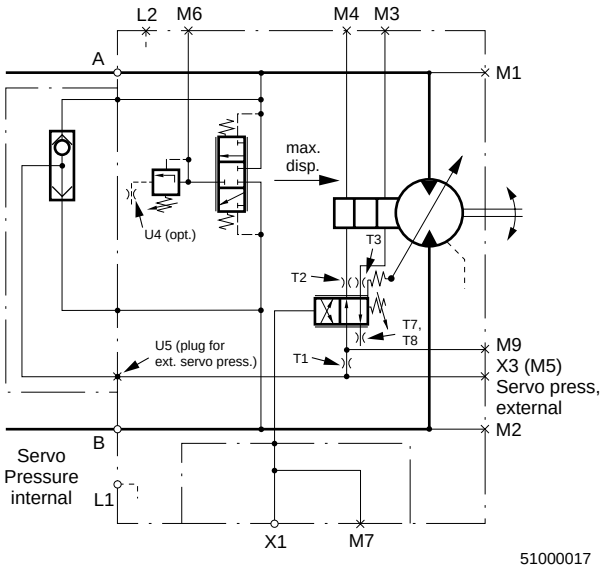

Fig. 10-19 - HZ Control Schematic

Functional Description (Continued)

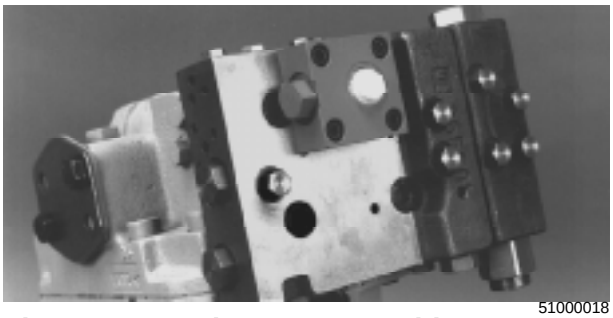

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Fig. 10-20 - Series 51 Motor with HS Control

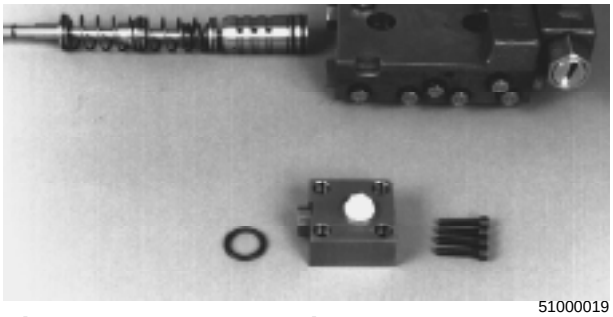

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Fig. 10-21 - HS Control Components

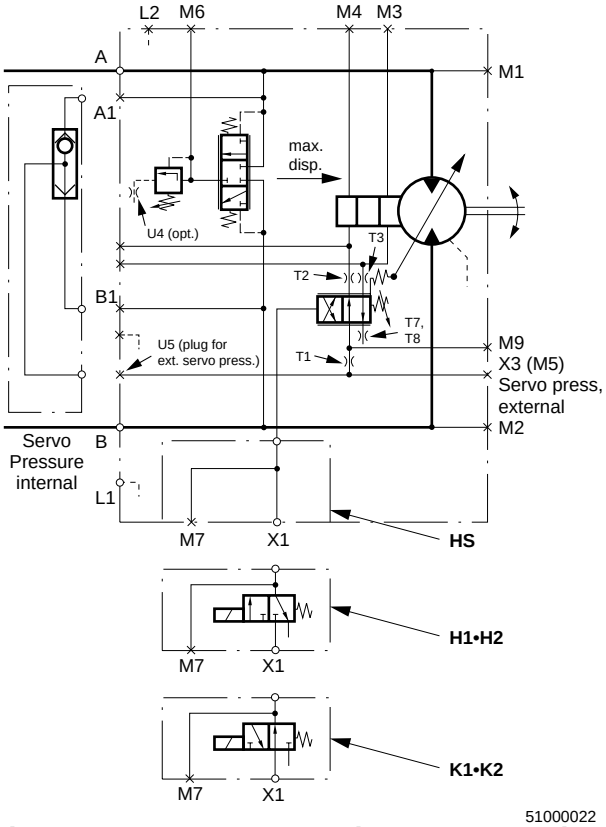

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Fig. 10-22 - HS, H1•H2, and K1•K2 Control Schematic

Hydraulic Proportional Control (Type HS)

The HS control consists of a cover plate (with a hydraulic port) mounted on the multi-function block. Servo pressure may be supplied from an external source or internally by the shuttle spool in the multi-function block. PCOR is available with this control.

The function of the HS control is identical to the function of the HZ control.

Functional Description (Continued)

Hydraulic Proportional Control with Electric Override (Types H1•H2 and K1•K2)

The function of the H1•H2 and K1•K2 controls is similar to the function of the HS control. A 12 or 24 VDC solenoid valve is installed between the external pilot pressure source and the control spool.

With the H1•H2 controls, energizing the solenoid allows the control to function as an HS control. When the solenoid is not energized, pilot pressure is blocked and the end of the control spool is drained to the motor case, causing the motor to shift to maximum displacement.

With the K1•K2 controls, energizing the solenoid blocks pilot pressure and drains the end of the control spool to the motor case, causing the motor to shift to maximum displacement. When the solenoid is not energized, the control functions as an HS control.

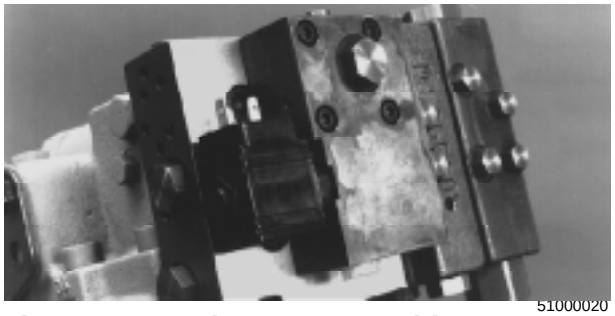
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Fig. 10-23 - Series 51 Motor with H1•H2 Control

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Fig. 10-24 - Series 51 Motor with K1•K2 Control

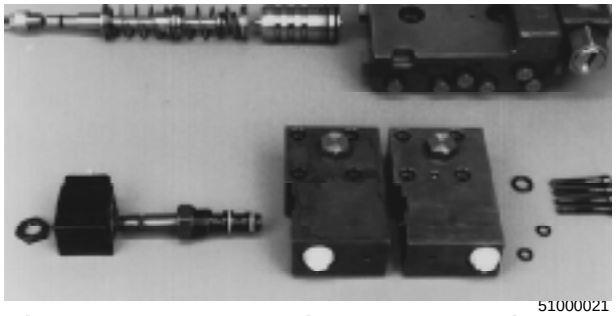
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Fig. 10-25 - H1•H2 and K1•K2 Control Components

Functional Description (Continued)

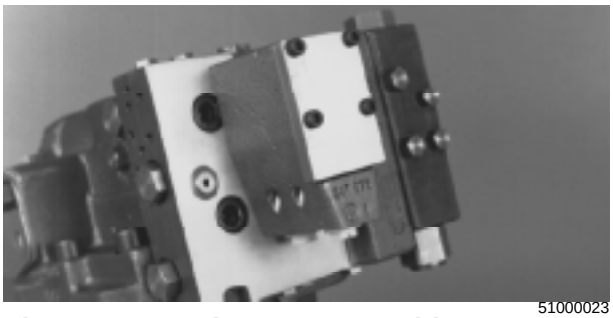

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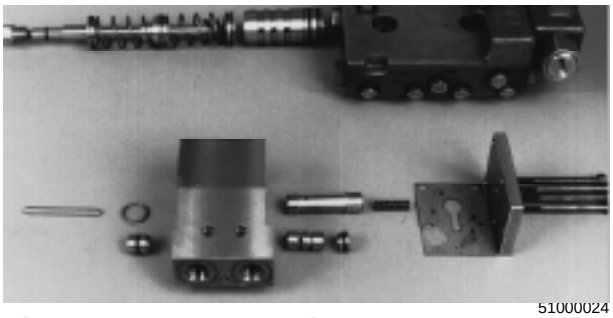
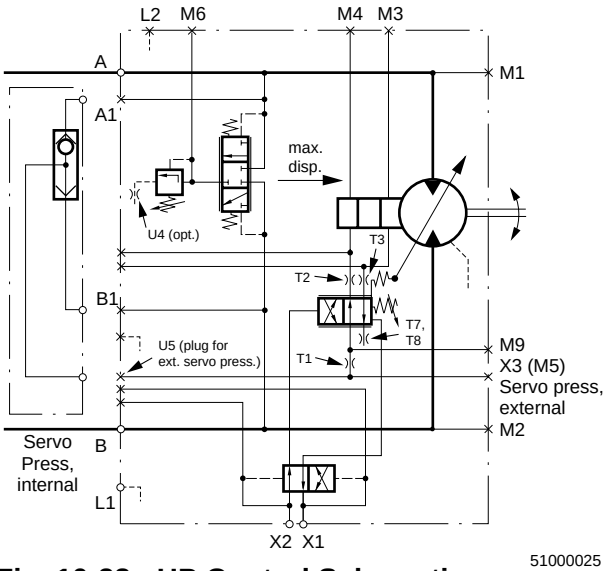
Fig. 10-26 - Series 51 Motor with HP Control



51000024

Fig. 10-27 - HP Control Components



51000025

Fig. 10-28 - HP Control Schematic

Two Line Hydraulic Proportional Control (Type HP)

This control consists of a valve block with two (2) hydraulic ports mounted on the multi-function block. The valve block incorporates a shuttle spool and a pilot piston with centering springs. A pin transmits force from the pilot piston to the control spool in the end cap. Feedback springs (single spring for 060, 080, and 110) and a threshold spring are installed in the end cap. These springs function similar to the HS control. Servo pressure may be supplied from an external source or internally by the shuttle spool in the multi-function block. PCOR is available with this control.

Two pilot pressures are provided to the control. The shuttle spool directs the higher pilot pressure to the end of the pilot piston opposite the feedback spring, and the lower pressure to the opposite side of the pilot piston. The rod transmits a force, proportional to the difference of the pilot pressures, to the control spool.

An increase in the difference between the pilot pressures will result in a decrease in motor displacement, while a decrease will result in an increase in displacement.

Functional Description (Continued)

Two Line Hydraulic Proportional Control for "Dual-Path" Vehicles (Type HC)

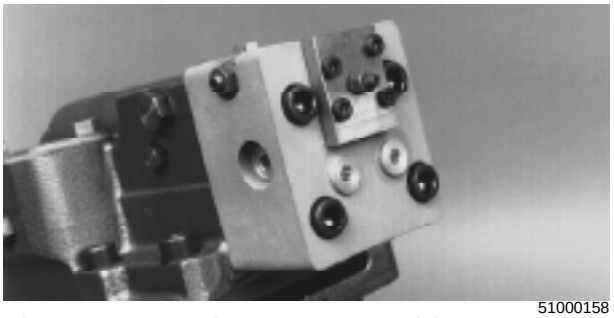
The HC control operates in a similar manner to the HP control, however the HC control is optimized for use in "dual-path" drive vehicles. This control consists of a valve block with two (2) hydraulic ports mounted on the end cap. The valve block incorporates a shuttle spool and a pilot piston with centering springs. A pin transmits force from the pilot piston to the control spool in the end cap.

A bleed valve is provided to eliminate any air which might become trapped in the pilot piston oil passages.

Feedback springs are installed in the end cap. Servo pressure is supplied internally by a ball type shuttle valve in the control housing. PCOR is not available with this control.

Two pilot pressures are provided to the control. The shuttle spool directs the higher pilot pressure to the end of the pilot piston opposite the feedback springs, and the lower pressure to the opposite side of the pilot piston. The pin transmits a force, proportional to the difference of the pilot pressures, to the control spool.

An increase in the difference between the pilot pressures will result in a decrease in motor displacement, while a decrease will result in an increase in displacement. The feedback springs in the end cap have differing spring rates and operate in parallel (060, 080, and 110) or series (160 or 250) to provide a linear relationship between motor displacement and pilot pressure differential.

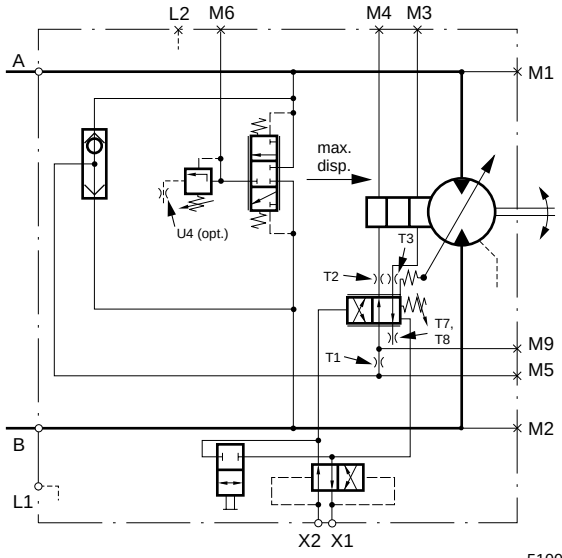


51000158

Fig. 10-29 - Series 51 Motor with HC Control

51000111

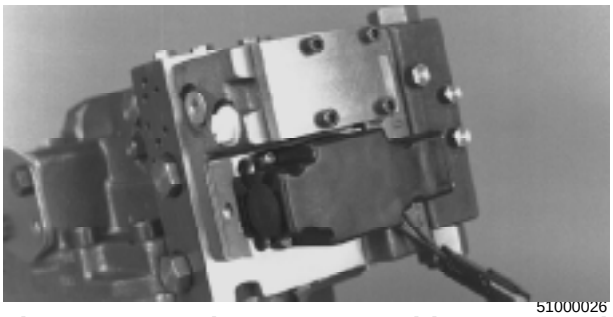
Fig. 10-30 - HC Control Components



51000160

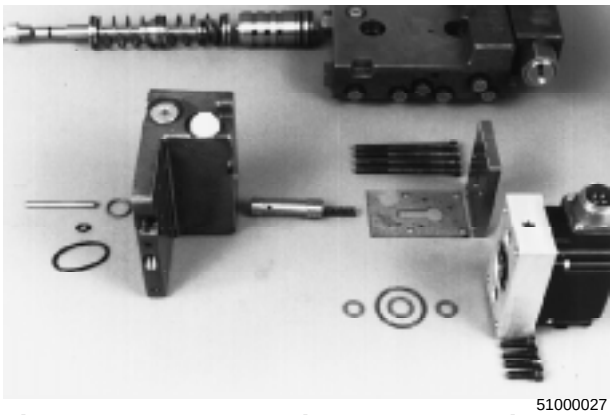
Fig. 10-31 - HC Control Schematic

Functional Description (Continued)



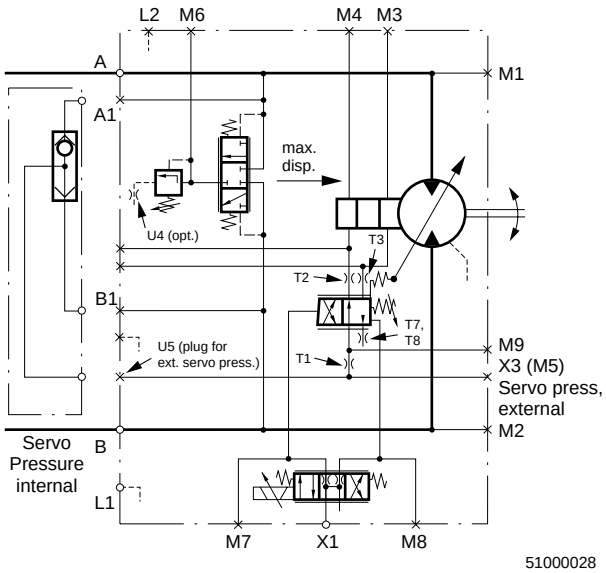
51000026

Fig. 10-32 - Series 51 Motor with EP Control (EQ Similar)



51000027

Fig. 10-33- EQ Control Components (EP Similar)



51000028

Fig. 10-34 - EP and EQ Control Schematic

Electrohydraulic Proportional Control (Types EP and EQ)

This control consists of a valve block and PCP (Pressure Control Pilot) valve mounted on the multi-function block. The valve block incorporates a pilot piston with centering springs. A pin transmits force from the pilot piston to the control spool in the end cap. Feedback springs (single spring for 060, 080, and 110) and a threshold spring are installed in the end cap. These springs function similar to the HS control. Servo pressure may be supplied from an external source or internally by the shuttle spool in the multi-function block. PCOR is available with this control.

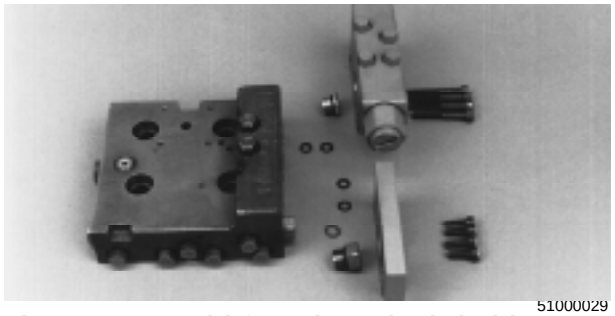
An external pilot pressure source is connected to the inlet of the PCP valve, which produces differential pilot pressures proportional to the current through it. These pressures are applied to the pilot piston. The operation of this control is similar to that of the HP Control, with the motor displacement being proportional to the current through the PCP valve.

An increase in current (above the threshold current) will result in a decrease in motor displacement, while a decrease will result in an increase in displacement.

Functional Description (Continued)

Multi-function Block Components

The Multi-function Valve Block includes a shuttle valve which provides internally supplied servo pressure, and an optional Pressure Compensator Over-Ride (PCOR) function with optional brake pressure defeat.



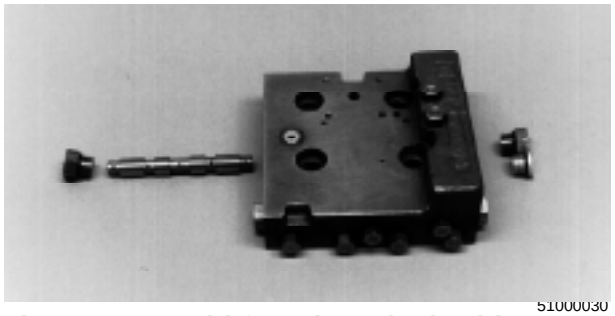
51000029

Fig. 10-35 - Multi-function Block (Without Control)

Servo Pressure Supply

For internal supply, the multi-function block incorporates a shuttle spool with internal check ball valve that routes oil from the main circuit ports of the motor to the control valve in the end cap. “High side” pressure is provided to the servo control valve in the end cap.

For external supply, the connection between the shuttle spool and the servo control valve is blocked in the end cap. The external pressure supply to the servo control valve connects to a port (“M5”) on the end cap.



51000030

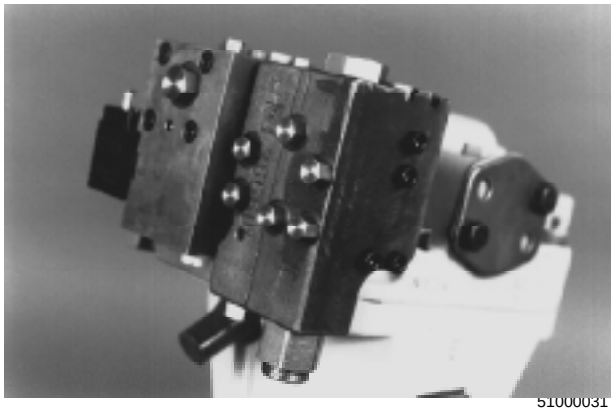
Fig. 10-36 - Multi-function Block with Servo Pressure Supply Shuttle Spool

Pressure Compensator Over-Ride (PCOR)

The Pressure Compensator Over-Ride (PCOR) system includes a spool valve located in the PCOR block which is attached to the multi-function block. This system increases the motor displacement at system pressures above the PCOR valve setting. (Pressure Compensator Over-Ride is not available with the N2 and HZ controls, or the PC regulator.)

For bi-directional PCOR operation, the shuttle valve in the multi-function block routes system high pressure to the PCOR spool valve. For single direction PCOR operation, the PCOR spool valve is connected to one (1) side of the closed loop through passages in the multi-function block

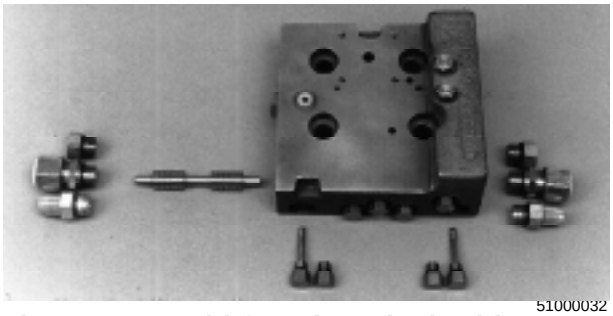
When system pressure exceeds the PCOR setting, the spool valve moves to connect the displacement reducing end of the servo piston to the motor case, and the displacement increasing end of the servo piston to system pressure. This increases the motor displacement, which reduces the motor output speed. When the PCOR valve closes, control of the servo piston returns to the control spool in the motor end cap.



51000031

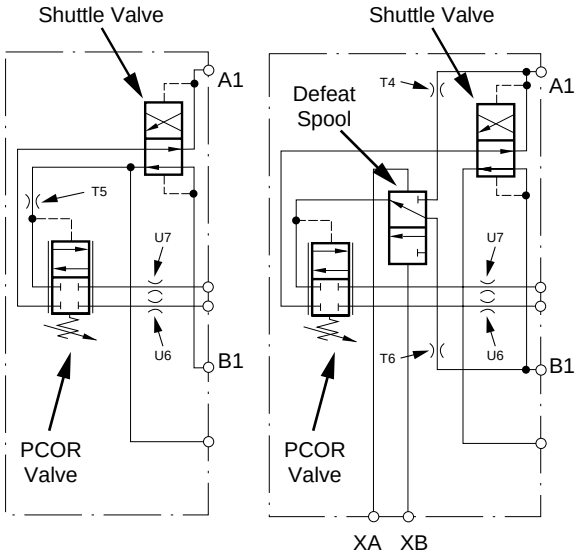
Fig. 10-37 - Multi-function Block with PCOR Block and Spool Valve (K1•K2 Control Shown)

Functional Description (Continued)



51000032

Fig. 10-38 - Multi-function Block with PCOR Defeat Spool Components



51000033

Fig. 10-39 - PCOR and PCOR with Defeat Schematic

An optional “brake pressure defeat” spool may be installed in the multi-function block. When used with the PCOR, this spool assures that the PCOR does not cause the motor displacement to increase during deceleration (which could cause pump overspeed). Pressure from a source such as the pump servos or an external valve, shifts the defeat spool to block the high pressure supply to the PCOR valve from the “deceleration” side of the closed loop. Either bi-directional or single direction PCOR operation can be specified when PCOR defeat is installed.

PCOR Brake Pressure Defeat Operation

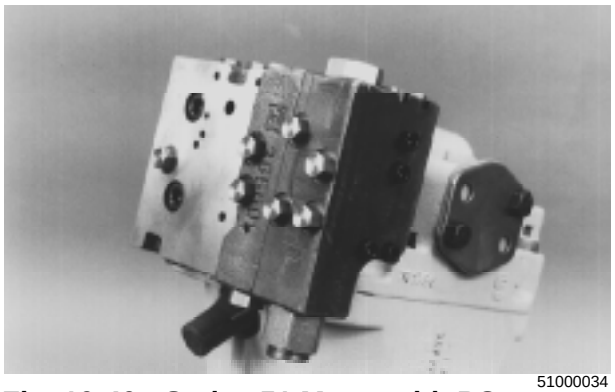
Rotation	High pressure port	Control pressure on port
CW	A	XB
CCW	B	XA

Functional Description (Continued)

Pressure Compensator Regulator (Type PC)

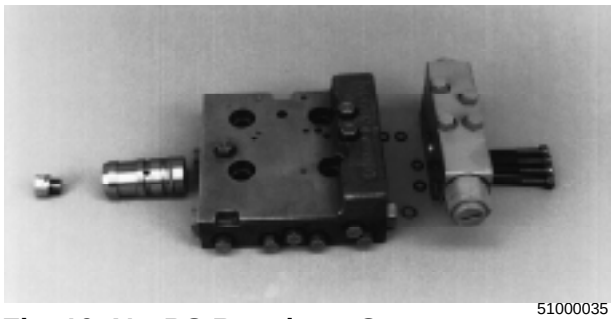
In this regulator, the Pressure Compensator system in the multi-function block assembly controls the motor displacement. At system pressures below the compensator setting, the servo piston is maintained in the minimum motor displacement position. When system pressure exceeds the POR setting, hydraulic pressure acts on the servo piston to increase the motor displacement.

With the Pressure Compensator regulator, an increase in system pressure (above the setting pressure) will result in an increase in motor displacement and output torque, and a decrease in motor shaft speed.



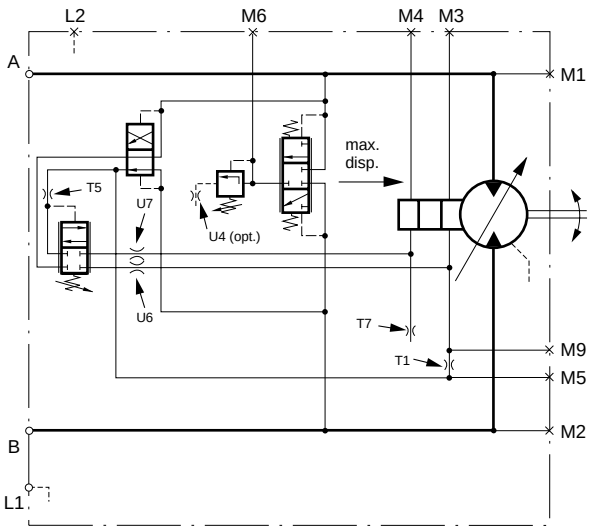
51000034

Fig. 10-40 - Series 51 Motor with PC Regulator



51000035

Fig. 10-41 - PC Regulator Components



51000036

Fig. 10-42 - PC Regulator Schematic

Technical Specifications and Data - Variable Displacement Motors

Design

Piston motor with variable displacement, bent axis construction.

Type of Mounting

SAE four (4) bolt flange – SAE Flange Configuration.
Two (2) bolt flange – Cartridge Motor Configuration.

Pipe Connections

Main pressure ports: SAE flange
Remaining ports: SAE O-ring thread

Direction of Rotation

Clockwise and counter-clockwise.

Installation Position

Installation position discretionary. The housing must always be filled with hydraulic fluid.

System Pressure Range, Input

Max: 480 bar (6960 psi)
Min: 10 bar (145 psi)

Case Pressure

Max. Continuous: 3 bar (44 psi)
Intermittent (Cold start): 5 bar (73 psi)

Hydraulic Fluid

Refer to Sauer-Sundstrand publication BLN-9887 or 697581.

Temperature [1)]

ϑ min = -40°C (-40°F), intermittent, cold start
ϑ nominal = 104°C (220°F), continuous
ϑ max = 115°C (240°F), intermittent

[1)] at the hottest point, normally the case drain line. Hydraulic fluid viscosity must be as shown below.

Fluid Viscosity Limits

ν min	=	5 mm^2/s (42 SUS)	intermittent
ν min	=	6.4 mm^2/s (47 SUS)	min. continuous
ν min	=	13 mm^2/s (70 SUS)	optimum
ν max	=	110 mm^2/s (510 SUS)	max. continuous
ν max	=	1600 mm^2/s (7400 SUS)	intermittent, cold start

Filtration

Acceptable contamination level: ISO Code 18/13 or better. Refer to Sauer-Sundstrand publication BLN-9887 or 697581.

		Dimension	Frame Size 060	080	110	160	250
Displacement	maximum	cm^3 in^3	60.0 3.66	80.7 4.92	109.9 6.71	160.9 9.82	250.0 15.26
	minimum	cm^3 in^3	12.0 0.73	16.1 0.98	22.0 1.34	32.2 1.96	50.0 3.05
Continuous speed	at max disp at min disp	min^{-1} (rpm) min^{-1} (rpm)	3600 5600	3100 5000	2800 4500	2500 4000	2200 3400
Max. speed	at max disp at min disp	min^{-1} (rpm) min^{-1} (rpm)	4400 7000	4000 6250	3600 5600	3200 5000	2700 4250
Theoretical torque	at max disp	Nm / bar lbf•in / 1000 psi	0.95 583	1.28 784	1.75 1067	2.56 1563	3.98 2428
	at min disp	Nm / bar lbf•in / 1000 psi	0.19 117	0.26 156	0.35 214	0.51 313	0.80 486
Max. continuous flow	Q max	L / min gal / min	216 57	250 66	308 81	402 106	550 145
Max. corner power	Pcorner max	kW hp	336 450	403 540	492 660	644 864	850 1140
Mass moment of inertia	J	$kg \cdot m^2$ $lbf \cdot ft^2$	0.0046 0.1092	0.0071 0.1685	0.0128 0.3037	0.0234 0.5553	0.0480 1.1580
Weight (with control N2)	m	kg lb	28 62	32 71	44 97	56 123	86 190

Safety Precautions

- When Series 51 units are used in vehicular hydrostatic drive systems, the loss of hydrostatic drive line power in any mode of operation may cause a loss of hydrostatic braking capacity. A braking system, redundant to the hydrostatic transmission must, therefore, be provided which is adequate to stop and hold the system should the condition develop.
- Certain service procedures may require the vehicle/machine to be disabled (wheels raised off the ground, work function disconnected, etc.) while performing them in order to prevent injury to the technician and bystanders.
- Use caution when dealing with hydraulic fluid under pressure. Escaping hydraulic fluid under pressure can have sufficient force to penetrate your skin causing serious injury. This fluid may also be hot enough to burn. Serious infection or reactions can develop if proper medical treatment is not administered immediately.
- Some cleaning solvents are flammable. To avoid possible fire, do not use cleaning solvents in an area where a source of ignition may be present.

Notes

Gauge Installation

Various pressure gauge readings can be a great asset in troubleshooting problems with the Series 51 motor or support system.

Snubbers are recommended to protect pressure gauges. Frequent gauge calibration is necessary to insure accuracy.

Fig. 30-1 - Gauge Ports, Motor with N2 Control

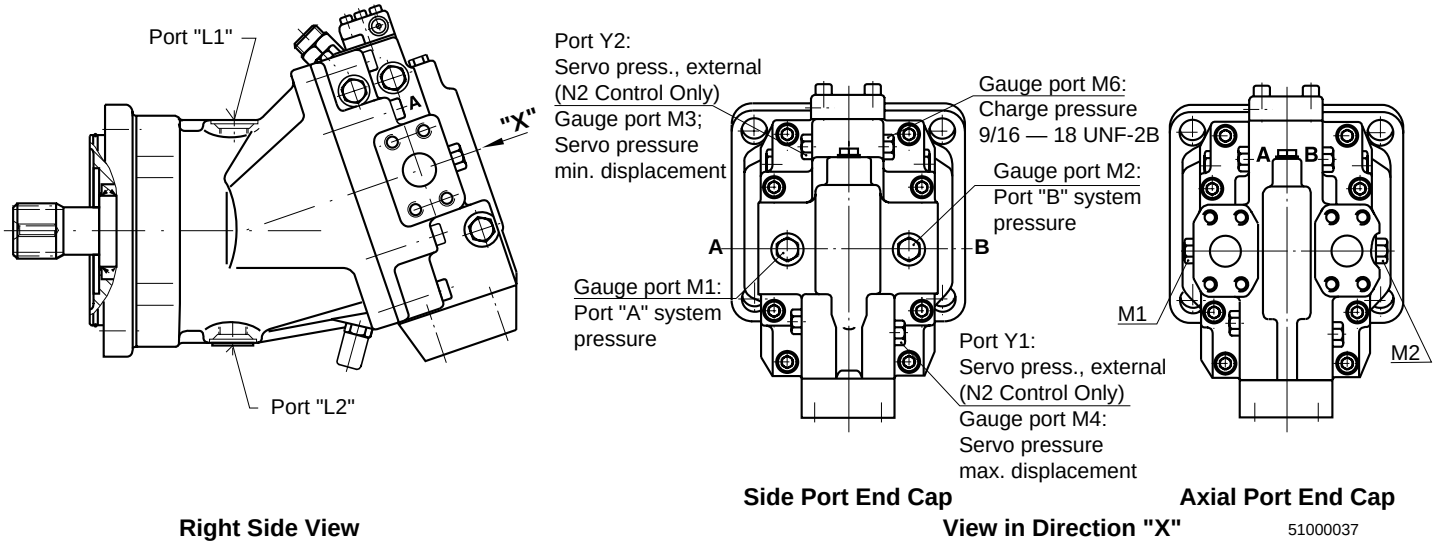


Fig. 30-2- Gauge Ports, Motor with E1•E2, F1•F2, H1•H2, and K1•K2 Controls

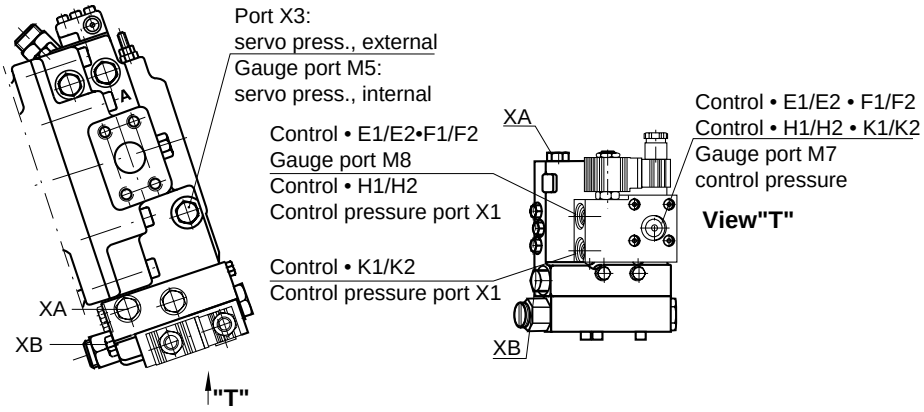
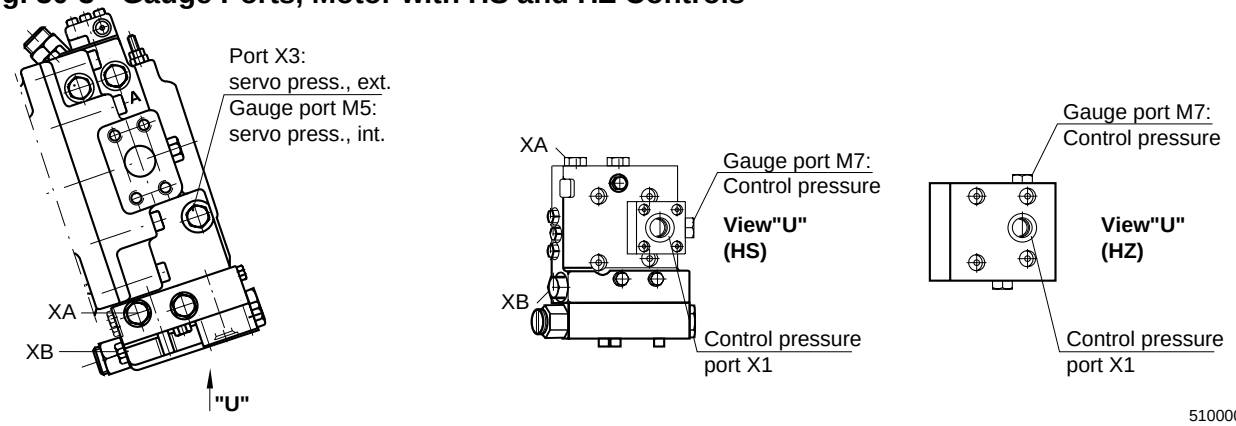


Fig. 30-3 - Gauge Ports, Motor with HS and HZ Controls



Gauge Installation (Continued)

Fig. 30-4 - Gauge Ports, Motor with HP Control

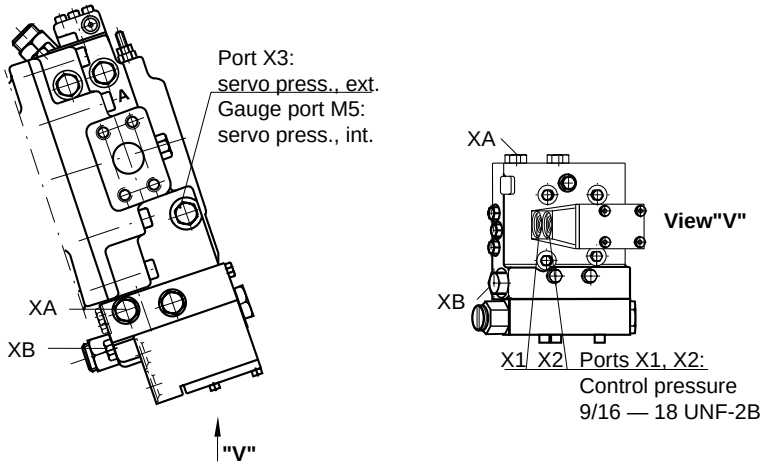
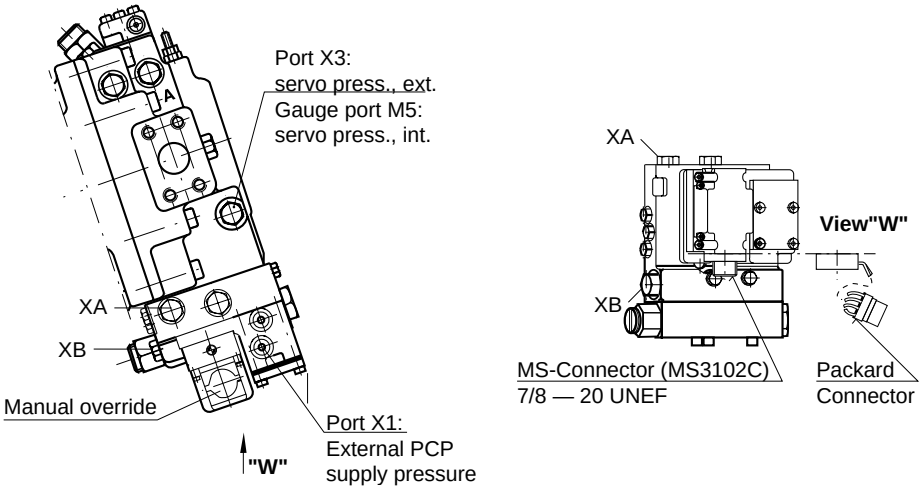


Fig. 30-5 - Gauge Ports, Motor with EP•EQ Control



Gauge Information

M1	System Pressure Port “A”	600 bar or 10,000 psi Gauge ——— 9/16 — 18 O-Ring Fitting
M2	System Pressure Port “B”	600 bar or 10,000 psi Gauge ——— 9/16 — 18 O-Ring Fitting
M3	Servo Pressure (Min. Angle)	600 bar or 10,000 psi Gauge ——— 9/16 — 18 O-Ring Fitting
M4	Servo Pressure (Max. Angle)	600 bar or 10,000 psi Gauge ——— 9/16 — 18 O-Ring Fitting
M5 (M9)	Servo Supply Pressure	600 bar or 10,000 psi Gauge 9/16 — 18 O-Ring Fitting or Tee into Control Pressure Line

M6	Motor Charge Pressure	60 bar or 1000 psi Gauge ——— 9/16 — 18 O-Ring Fitting
M7 M8	Control Test Port	60 bar or 1000 psi Gauge 9/16 — 18 O-Ring Fitting
L1 L2	Case Pressure	60 bar or 1000 psi Gauge **060, 080, 110**: 1-1/16 — 12 O-Ring Fitting **160, 250**: 1-5/16 — 12 O-Ring Fitting
X1 X2 X3	Control Pressure	60 bar or 1000 psi Gauge 9/16 — 18 O-Ring Fitting
XA XB	Defeat Pressure	60 bar or 1000 psi Gauge Tee into Defeat Pressure Line(s)

Start-Up Procedure and Maintenance

Start-Up Precautions

Cleanliness

Ensure that all system components, including fittings, pipes, and hoses, are completely clean. If cloths are used for cleaning components, they must be made of lint-free materials.

Follow the guidelines presented in Sauer-Sundstrand publication BLN-9887 or 697581 for required fluid cleanliness levels at machine start-up.

Reservoir and Fluid Level

The reservoir should be designed to accommodate maximum volume changes during all system operating modes, and to promote de-aeration of the fluid as it passes through the tank. The reservoir outlet (charge pump inlet) and the reservoir inlet (fluid return) must always be below the normal fluid level. A sight glass is the preferred method for checking fluid level.

The reservoir inlet (fluid return) should be positioned so that flow to the reservoir is directed into the interior of the reservoir for maximum dwell and efficient de-aeration. A baffle (or baffles) between the reservoir inlet and outlet ports will promote de-aeration and reduce surging of the fluid.

No funnel-shaped eddying at the reservoir outlet (charge pump inlet) or formation of foam at the reservoir inlet (fluid return) is permitted.

Start-Up Procedure

The following start-up procedure should always be followed when starting-up a new Series 51 installation or when restarting an installation in which either the pump or motor has been removed from the system.

WARNING

The following procedure may require the vehicle/machine to be disabled (wheels raised off the ground, work function disconnected, etc.) while performing the procedure in order to prevent injury to the technician and bystanders. Take necessary safety precautions before operating the vehicle/machine.

Prior to installing the motor, inspect the unit for damage incurred during shipping and handling. Make certain all system components (reservoir, hoses, valves, fittings, heat exchanger, etc.) are clean prior to filling with fluid.

Fill the reservoir with recommended hydraulic fluid, which should be passed through a 10 micron (nominal, no bypass) filter prior to entering the reservoir. The use of contaminated fluid will cause damage to the components, which may result in unexpected vehicle/machine movement.

The inlet line leading from the reservoir to the pump must be filled prior to start up. Check inlet line for properly tightened fittings and make sure it is free of restrictions and air leaks.

Be certain to fill the pump and motor housing with clean hydraulic fluid prior to start up. Fill the housing by pouring filtered oil into the upper case drain port.

Install a 0 to 60 bar or 0 to 1000 psi pressure gauge in the charge pressure gauge port to monitor the charge pressure during start-up.

The external control input signal should be disconnected at the pump control during initial start-up. This will allow the pump to remain in its neutral position.

“Jog” or slowly rotate prime mover until charge pressure starts to rise. Start the prime mover and run at the lowest possible RPM until charge pressure is established. Excess air may be bled from the high pressure lines through the high pressure gauge ports.

Once charge pressure is established, increase speed to normal operating RPM. Note the charge pressure. If charge pressure is incorrect, shut down and determine cause for improper pressure.

Shut down prime mover and connect external control input signal. Start prime mover, checking to be certain pump remains in neutral. With prime mover at normal operating speed, slowly check for forward and reverse machine operation.

Charge pressure should be maintained during forward or reverse operation. Continue to cycle slowly between forward and reverse for at least five (5) minutes.

Shut down prime mover, remove gauges, and plug ports. Check reservoir level and add fluid if necessary.

The transmission is now ready for operation.

Start-Up Procedure and Maintenance (Continued)

Maintenance

Cleanliness

The reservoir breather air filter (if equipped) must be kept clean. Clean the area around the filler cap before opening the reservoir. The hydraulic fluid should be filtered before it enters the reservoir.

Follow the guidelines presented in Sauer-Sundstrand publication BLN-9887 or 697581 for required fluid cleanliness levels during machine operation.

Recommended Fluids

Hydraulic fluids used with Sauer-Sundstrand products should be carefully selected with assistance from a reputable supplier, following the guidelines presented in Sauer-Sundstrand publication BLN-9887 or 697581.

Checking for Leaks

Check the system components for leakage at regular intervals. Tighten any leaking connections while the system is not under pressure. Replace any defective seals and gaskets.

Check hydraulic hoses for damage or aging. When installing replacements, be certain that the hoses are clean and connected properly.

Checking the Fluid Level

Check the reservoir daily for proper fluid level, the presence of water (noted by a cloudy or milky appearance, or free water in bottom of reservoir), and rancid fluid odor (indicating excessive heat).

Changing the Fluid and Filter

To insure optimum service life on Series 51 products, regular maintenance of the fluid and filter must be performed.

The fluid and filter must be changed per the vehicle/machine manufacturer's recommendations. In the absence of such recommendations, the following intervals may be used:

- System with a sealed type reservoir - 2000 hrs.
- System with a breathing type reservoir - 500 hrs.

It may be necessary to change the fluid more frequently if the fluid becomes contaminated with foreign matter (dirt, water, grease, etc.) or if the fluid has been operating at temperature levels greater than the maximum recommended. Never reuse fluid.

The filter should be changed when changing the fluid, or whenever the filter indicator shows that it is necessary to change the filter.

Component Inspection and Adjustment

WARNING

The following procedures may require the vehicle/machine to be disabled (wheels raised off the ground, work function disconnected, etc.) while performing the adjustments to prevent injury to the technician and bystanders.

Charge Pressure Relief Valve Adjustment

An appropriate combination of pump and motor charge pressure settings should be maintained to insure the proper function of the loop flushing circuit. **Correct charge pressure must be maintained under all conditions of operation to maintain pump control performance in closed loop systems.**

To measure motor charge pressure, install a 0 to 60 bar or 0 to 500 psi pressure gauge in the motor charge pressure gauge port. Install a gauge to measure case pressure. Operate the system with the prime mover at normal operating speed and the pump at half stroke (forward or reverse) when measuring motor charge pressure.

In most applications, the motor charge relief valve is set 2 to 4 bar (29 to 58 psi) below the setting of the pump charge relief valve (measured with the pump in its “neutral” or zero-angle position). This setting assumes a reservoir temperature of 50° C (122° F), and is referenced to case pressure.

Series 51 motors are equipped with an external screw adjustable charge pressure relief valve. To adjust the charge pressure, loosen the lock nut (with a 1-1/16" hex wrench) and turn the adjustment plug with a large screwdriver. Clockwise rotation of the plug increases the setting, and counter-clockwise rotation decreases the setting (at a rate of approximately 3.4 bar [50 psi] per turn). The lock nut should be torqued to 52 Nm (38 ft•lbsf).

Once the desired charge pressure setting is achieved, remove the gauges and reinstall the port plugs.

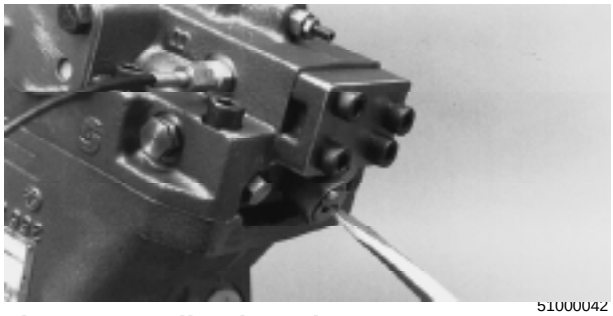

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Fig. 30-6 - Adjusting Charge Pressure Relief Valve

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Fig. 30-7 - Tighten Charge Pressure Relief Valve Lock Nut

Component Adjustment (Continued)

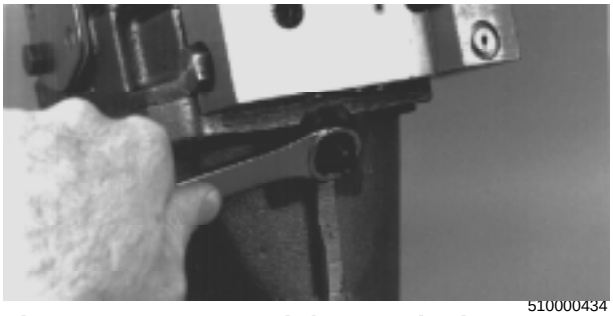

Fig. 30-8 - Loosen Minimum Displacement Limiter Lock Nut

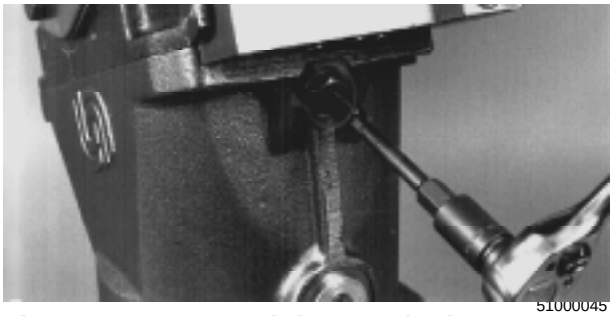

Fig. 30-9 - Rotate Minimum Displacement Adjusting Screw

Frame Size	Approximate Change in Minimum Displacement Per Revolution of Adjusting Screw
060	1.5 cc/Rev (.09 in3/Rev)
080	2.1 cc/Rev (.13 in3/Rev)
110	3.1 cc/Rev (.19 in3/Rev)
180	4.0 cc/Rev (.24 in3/Rev)
250	6.2 cc/Rev (.38 in3/Rev)

Frame Size	Min. Displacement Range cc/Rev (in/Rev)	Screw Size and Length mm (in)
060	12 to 29 (.73 to 1.77) 30 to 40 (1.83 to 2.44)	M10x65 (2.56) M10x80 (3.15)
080	16 to 35 (.98 to 2.14) 36 to 54 (2.20 to 3.20)	M10x65 (2.56) M10x80 (3.15)
110	22 to 46 (1.34 to 2.81) 47 to 74 (2.87 to 4.52)	M12x70 (2.76) M12x80 (3.15)
160	32 to 72 (1.95 to 4.39) 73 to 107 (4.45 to 6.53)	M12x75 (2.95) M12x90 (3.54)
250	50 to 90 (3.05 to 5.49) 91 to 130 (5.55 to 7.93) 131 to 167 (7.99 to 10.19)	M12x75 (2.95) M12x90 (3.54) M12x100 (3.94)

Minimum Displacement Limiter Adjustment

The minimum displacement is set at the factory, and the adjustment screw is covered with a tamper-resistant cap

WARNING

Care should be taken in adjusting displacement limiters to avoid undesirable speed conditions. The sealing lock nut must be retorqued after every adjustment to prevent an unexpected change in operating conditions and to prevent external leakage during unit operation.

NOTE: Changes in motor displacement can be detected by providing a constant flow of fluid to the motor, while maintaining the motor at minimum displacement and monitoring the motor output shaft speed. An increase in displacement will result in a decrease in shaft speed, while a decrease in displacement will result in an increase in shaft speed.

To adjust the minimum displacement, first remove and discard the cap covering the adjusting screw. Using a 17 mm hex wrench for 060 and 080 frame size motors or a 19 mm hex wrench for 110 through 250 frame size motors, loosen the lock nut retaining the minimum displacement limiter adjusting screw.

Using a 5 mm internal hex wrench for 060 and 080 frame size motors or a 6 mm internal hex wrench for 110 through 250 frame size motors, rotate the adjusting screw to limit the minimum displacement of the motor.

Rotating the adjusting screw clockwise will increase the minimum displacement of the motor, while rotating the adjusting screw counter-clockwise will decrease the minimum displacement.

For each full revolution, of the adjusting screw, the displacement will change according to the accompanying chart.

Different minimum displacements may require different length adjusting screws. The various lengths are shown in the accompanying chart.

After establishing the desired minimum displacement setting, tighten the lock nut on the adjusting screw to 51 Nm (38 ft•lbsf) for 060 and 080 frame size motors or 86 Nm (63 ft•lbsf) for 110 through 250 frame size motors. Install a new tamper-resistant cap on the adjusting screw.

Component Adjustment (Continued)

Maximum Displacement Limiter Adjustment

The maximum displacement of the Series 51 motors can be limited by limiting the stroke of the setting piston, and the resulting movement of the valve segment. A displacement stop screw is installed on the setting piston (under the minimum angle servo cover) to limit the stroke of the piston.

Spacers may be installed on the displacement stop screw to limit the stroke. A longer or shorter screw must be used to retain a thicker or thinner spacer.

WARNING

Care should be taken in adjusting displacement limiters to avoid undesirable speed conditions. The stop screw must be retorqued after adjustment to prevent an unexpected change in operating conditions.

NOTE: Changes in motor displacement can be detected by providing a constant flow of fluid to the motor, while maintaining the motor at maximum displacement and monitoring the motor output shaft speed. An increase in displacement will result in a decrease in shaft speed, while a decrease in displacement will result in an increase in shaft speed.

To adjust the maximum displacement, first remove the screws retaining the minimum angle servo cover to the end cap with an 8 mm internal hex wrench (060, 080, 110, and 160 units), or a 10 mm internal hex wrench (250 units). Remove the minimum angle servo cover and O-rings. Remove the displacement limiter screw with an 8 mm internal hex wrench.

Installing a thicker spacer on the end of the setting piston will reduce the maximum displacement of the motor. Installing a thinner spacer will increase the maximum displacement. The displacement will change according to the accompanying chart.

Torque the displacement limiter screw to 54 Nm (40 ft•lbsf).

Install the minimum angle servo cover and its O-rings. Install the cover screws and torque to 78 Nm (58 ft•lbsf) for 060, 080, 110, and 160 motors, or 110 Nm (81 ft•lbsf) for 250 motors.

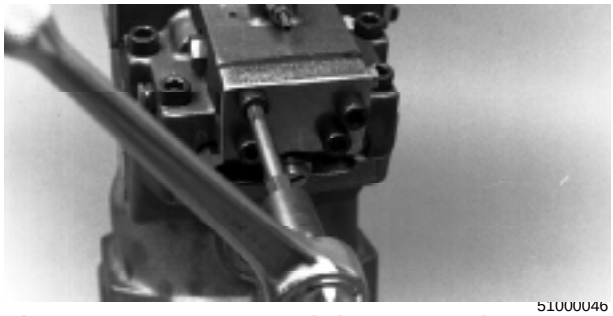

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Fig. 30-10 - Remove Minimum Angle Servo Cover Screws

Frame Size	Approximate Change in Maximum Displacement with Change in Spacer Thickness cc/mm (in³/.1 in)
060	0.98 (.15)
080	1.14 (.18)
110	1.48 (.23)
160	1.93 (.30)
250	2.63 (.41)

51000070

Fig. 30-11 - Torque Maximum Displacement Limiter Screw

Component Adjustment (Continued)

Displacement Control Adjustments

NOTE: A change in motor displacement can be detected by providing a constant flow of fluid to the motor and monitoring the motor output shaft speed while adjusting the control. An increase in displacement will result in a decrease in shaft speed, while a decrease in displacement will result in an increase in shaft speed.

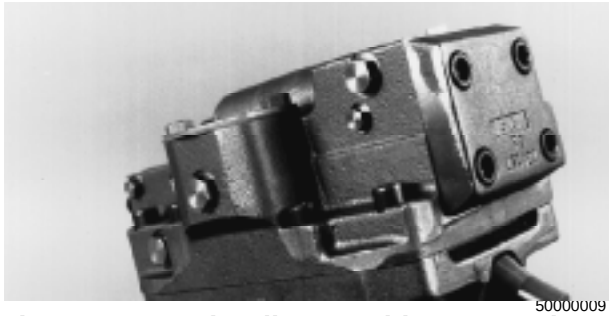

Fig. 30-12 - Hydraulic 2-Position Control, Type N2)

Hydraulic 2-Position Control (Type N2)

No adjustments are provided for the N2 control.

A minimum of 25 bar (360 psi) servo pressure is required to change the motor displacement with the motor shaft turning. A minimum of 70 bar (1015 psi) servo pressure is required to change the motor displacement with the motor shaft locked.

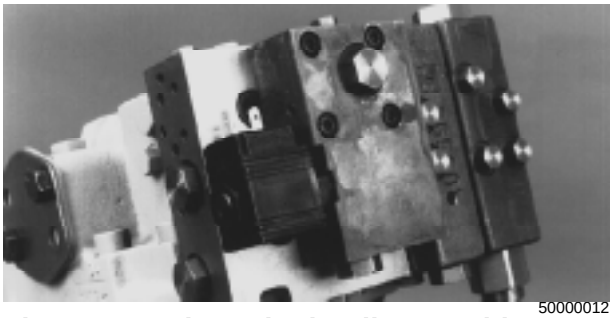

Fig. 30-13 - Electrohydraulic 2-Position Control, Types E1•E2 and F1•F2

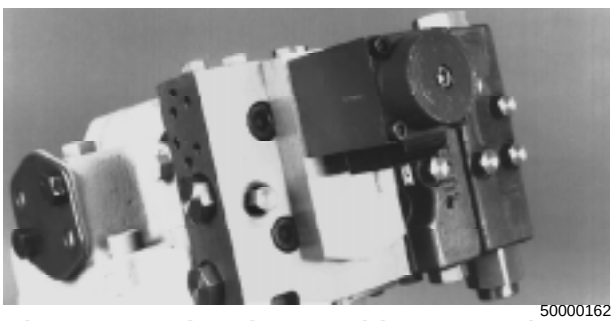

Fig. 30-14 - Electric 2-Position Control, Type S1

Electrohydraulic 2-Position Control (Types E1•E2 and F1•F2) and Electric 2-Position Control (Type S1)

These controls do not require adjustment.

CAUTION

Do not tamper with the adjusting screw in the end cap (opposite the control).

Pilot pressure for the E1•E2 or F1•F2 electric solenoid valve is internally supplied. When the solenoid is energized, motor charge pressure should be present at test ports M7 and M8. When the solenoid is not energized, test port M8 should drop to case pressure.

The S1 control utilizes a direct acting solenoid to operate the control valve spool in the end cap.

Servo pressure supply oil is usually provided internally from the main system ports of the motor. If external servo pressure supply is utilized, a minimum of 25 bar (360 psi) is required to change the motor displacement with the motor shaft turning, and a minimum of 70 bar (1015 psi) is required with the motor shaft locked.

Component Adjustment (Continued)

Hydraulic Proportional Control (Types HZ, HS, H1•H2, and K1•K2)

The control start pressure for these controls may be adjusted with the adjusting screw on the end cap (opposite the control block). Control start is that pilot pressure at which the motor displacement starts to decrease.

To check the control start setting, install a gauge to monitor the pilot pressure (connect to port M7 or tee into the pilot line connected to port X1), and the minimum angle servo pressure (port M3). If adjusting an H1 or H2 control, the override solenoid must be energized. If adjusting a K1 or K2 control, the solenoid must not be energized.

NOTE: The pilot signal may be determined by prime mover speed, other shaft speeds, or other control pressures, depending upon the design of the vehicle / machine control circuit.

Increase the pilot signal to the required control start pressure. An increase in minimum angle servo pressure will be noted as the motor displacement starts to decrease.

To adjust the control start pressure, loosen the lock nut using a 10 mm hex wrench and turn the adjusting screw with a 4 mm internal hex wrench. Turning the screw clockwise increases the control start pressure. Torque the lock nut to 9 Nm (6.6 ft•lbsf) after adjusting.

For the H1•H2 controls, the pilot signal pressure supplied to port X1 should also be present at test port M7 when the solenoid is energized. When the solenoid is not energized, test port M7 should drop to case pressure.

For the K1•K2 controls, the pilot signal pressure supplied to port X1 should also be present at test port M7 when the solenoid is not energized. When the solenoid is energized, test port M7 should drop to case pressure.

Shut down the prime mover. Remove the gauges and install the gauge port plugs. Return the pump and motor controls to their normal operation.

Servo pressure supply oil is usually provided internally from the main system ports of the motor. If external servo pressure supply is utilized, a minimum of 25 bar (360 psi) is required to change the motor displacement with the motor shaft turning, and a minimum of 70 bar (1015 psi) is required with the motor shaft locked.

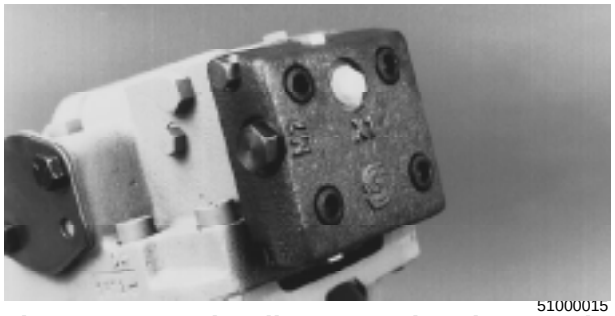

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Fig. 30-15 - Hydraulic Proportional Control, Type HZ

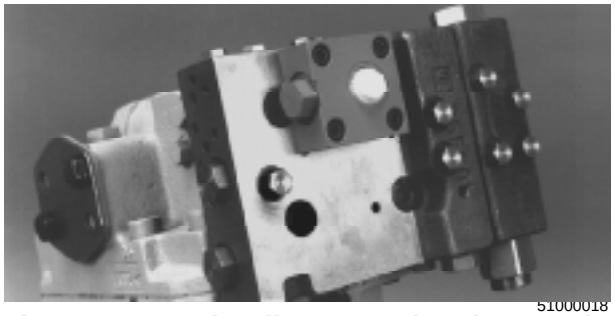
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Fig. 30-16 - Hydraulic Proportional Control, Type HS

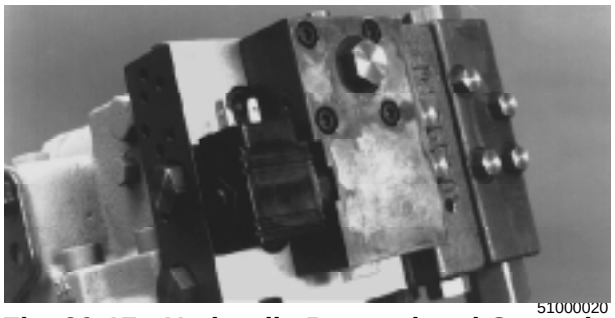
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Fig. 30-17 - Hydraulic Proportional Control with Electric Override, Type H1•H2 (K1•K2 Similar)

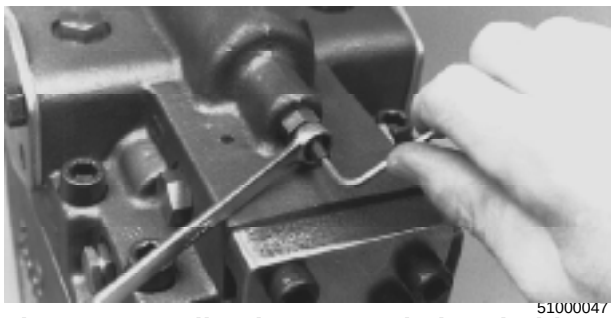
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Fig. 30-18 - Adjusting Control Threshold, Types HS, HZ, H1•H2, and K1•K2

Component Adjustment (Continued)

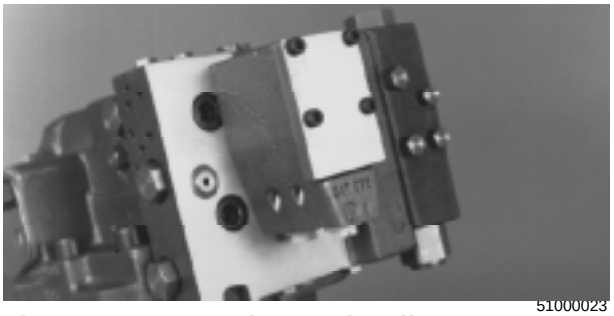

Fig. 30-19 - Two Line Hydraulic Proportional Control, Type HP

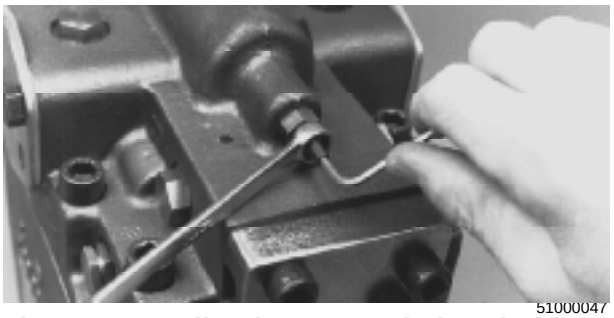

Fig. 30-20 - Adjusting Control Threshold (Type HP)

Two Line Hydraulic Proportional Control (Type HP)

The differential control start pressure for this control may be adjusted with the adjusting screw on the end cap (opposite the control block). Control start is that differential pilot pressure at which the motor displacement starts to decrease.

To check the control start setting, install gauges to monitor the pilot pressures (tee into the pilot lines connected to ports X1 and X2), and the minimum angle servo pressure (port M3).

NOTE: The pilot signals may be determined by prime mover speed, other shaft speeds, or other control pressures, depending upon the design of the vehicle / machine control circuit.

Increase the pilot signal differential to the required control start pressure. An increase in minimum angle servo pressure will be noted as the motor displacement starts to decrease.

The differential control start pressure should be the same no matter which pilot pressure is higher. Differences in control operation when the pilot pressure differential is reversed indicate a problem with the shuttle spool in the control block.

To adjust the control start differential pressure, loosen the lock nut using a 10 mm hex wrench and turn the adjusting screw with a 4 mm internal hex wrench. Turning the screw clockwise increases the control start pressure. Torque the lock nut to 9 Nm (6.6 ft•lbsf) after adjusting.

Shut down the prime mover. Remove the gauges and install the gauge port plugs. Return the pump and motor controls to their normal operation.

Servo pressure supply oil is usually provided internally from the main system ports of the motor. If external servo pressure supply is utilized, a minimum of 25 bar (360 psi) is required to change the motor displacement with the motor shaft turning, and a minimum of 70 bar (1015 psi) is required with the motor shaft locked.

Component Adjustment (Continued)

Two Line Hydraulic Proportional Control for "Dual Path" Vehicles (Type HC)

The differential control start pressure for this control may be adjusted with the adjusting screw on the control housing. Control start is that differential pilot pressure at which the motor displacement starts to decrease.

To check the control start setting, install gauges to monitor the pilot pressures (tee into the pilot lines connected to ports X1 and X2), and the minimum angle servo pressure (port M3).

NOTE: The pilot signals may be determined by prime mover speed, other shaft speeds, or other control pressures, depending upon the design of the vehicle / machine control circuit.

Increase the pilot signal differential to the required control start pressure. An increase in minimum angle servo pressure will be noted as the motor displacement starts to decrease.

The differential control start pressure should be the same no matter which pilot pressure is higher. Differences in control operation when the pilot pressure differential is reversed indicate a problem with the shuttle spool in the control block.

To adjust the control start differential pressure, loosen the lock nut using a 10 mm hex wrench and turn the adjusting screw with a 4 mm internal hex wrench. Turning the screw counter-clockwise (CCW) increases the control start pressure. Torque the lock nut to 9 Nm (6.6 ft•lbsf) after adjusting.

Shut down the prime mover. Remove the gauges and install the gauge port plugs. Return the pump and motor controls to their normal operation.

Servo pressure supply oil is provided internally from the main system ports of the motor.

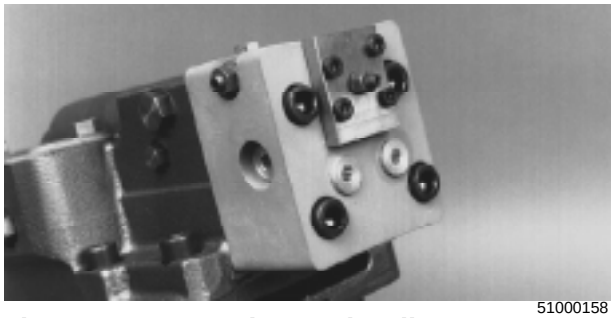

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Fig. 30-21 - Two Line Hydraulic Proportional Control, Type HC

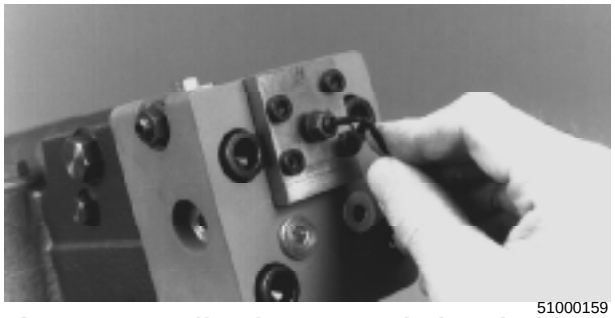

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Fig. 30-22 - Adjusting Control Threshold (Type HC)

Component Adjustment (Continued)

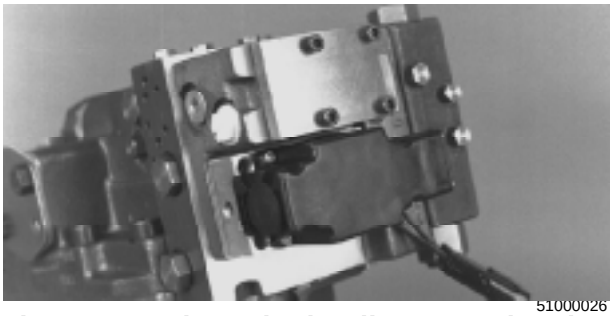

Fig. 30-23 - Electrohydraulic Proportional Control, Type EP (EQ Similar)

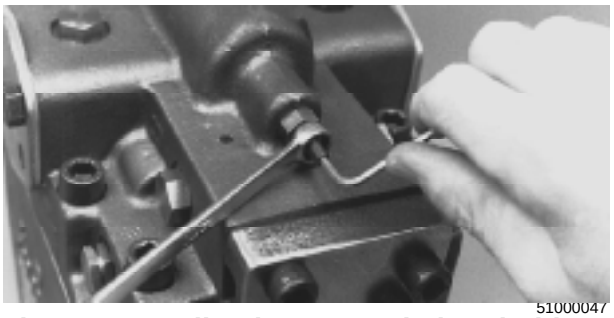

Fig. 30-24 - Adjusting Control Threshold (Type EP•EP)

Electrohydraulic Proportional Control (Types EP and EQ)

The control start current for the EP and EQ controls may be adjusted with the adjusting screw on the end cap (opposite the control block). Control start is that current supplied to the PCP (Pressure Control Pilot) valve at which the motor displacement starts to decrease.

To check the threshold setting, install instruments to monitor the PCP current, and the minimum angle servo pressure (port M3).

NOTE: The current supplied to the PCP may be determined by prime mover speed, other shaft speeds, control pressures, or other electrical signals, depending upon the design of the vehicle / machine control circuit.

Increase the PCP current to the required control start current. An increase in minimum angle servo pressure will be noted as the motor displacement starts to decrease.

To adjust the control start current, loosen the lock nut using a 10 mm hex wrench and turn the adjusting screw with a 4 mm internal hex wrench. Turning the screw clockwise increases the control start current. Torque the lock nut to 9 Nm (6.6 ft•lbsf) after adjusting.

PCP supply pressure oil is provided externally. PCP supply pressure must be a minimum of 20 bar (290 psi) and no more than 70 bar (1015 psi).

Shut down the prime mover. Remove the gauges and install the gauge port plugs. Return the pump and motor controls to their normal operation.

Servo pressure supply oil is usually provided internally from the main system ports of the motor. If external servo pressure supply is utilized, a minimum of 25 bar (360 psi) is required to change the motor displacement with the motor shaft turning, and a minimum of 70 bar (1015 psi) is required with the motor shaft locked.

Component Adjustment (Continued)

Pressure Compensator Over-Ride (PCOR) and Pressure Compensator Regulator (Type PC) Adjustment

The PCOR or PC regulator valve setting may be adjusted with the adjusting screw on the PCOR/PC valve block attached to the multi-function block. The regulator start pressure is that system pressure at which the PCOR or PC regulator starts to increase the motor displacement.

In order to measure the regulator start pressure setting of the PCOR or the PC regulator, the motor output shaft must be loaded to increase the system working pressure. This can accomplished by applying the vehicle's brakes or by loading the work function.

WARNING

The following procedures may require the vehicle/machine to be disabled (wheels raised off the ground, work function disconnected, etc.) while performing the adjustment to prevent injury to the technician and bystanders.

Install gauges to monitor system pressure (connect to ports M1 and M2), the minimum angle servo pressure (port M3), and the maximum angle servo pressure (port M4).

Start the prime mover and operate at normal speed. Provide a signal to the pump control to provide a constant flow of hydraulic fluid to the motor. Provide a signal to the motor control to maintain the motor at its minimum displacement.

Increase the load on the motor to increase the system pressure to the required regulator start pressure. The maximum angle servo pressure (M4) will increase and the minimum displacement servo pressure (M3) will decrease as the PCOR or PC regulator operates. The servo pressures will equalize, and the maximum angle servo pressure continue to increase, as the motor displacement starts to increase.

During the transition from minimum to maximum displacement, an additional 10 bar (145 psi) increase in system pressure may be noted.

Once the motor is at maximum displacement, further increases in load will result in increasing system pressure until the maximum system pressure (determined by the system relief valve or pump pressure limiter) is reached.

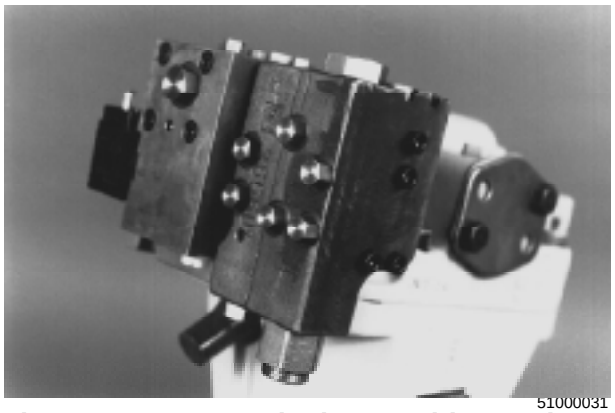
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Fig. 30-25 - PCOR Block on Multi-Function Block (K1•K2 Control Shown)

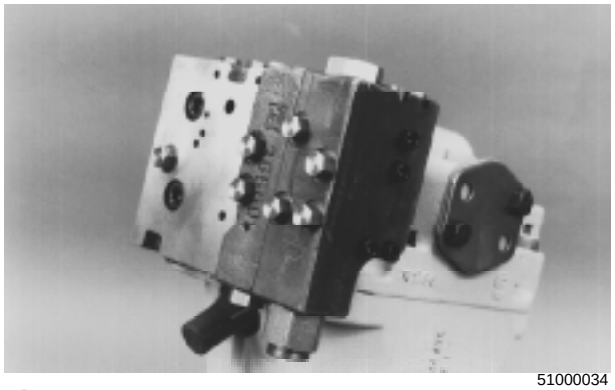
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Fig. 30-26 - Pressure Compensator Regulator (Type PC)

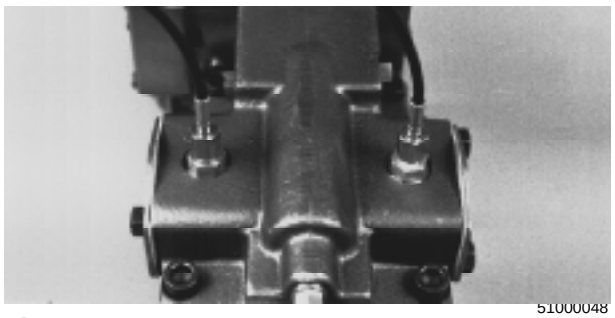
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Fig. 30-27 - System Pressure Gauge Ports (Side Port End Cap)

Component Adjustment (Continued)

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Fig. 30-28 - Loosen PCOR/PC Lock Nut

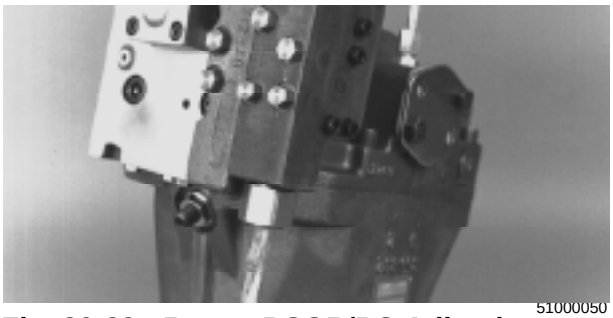

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Fig. 30-29 - Rotate PCOR/PC Adjusting Screw

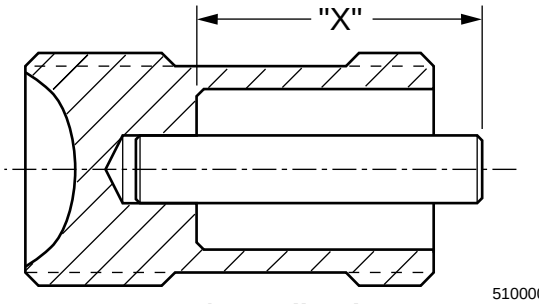

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Fig. 30-30 - PCOR/PC Adjusting Screw Stop Pin

Allow the pump to return to its neutral position. Repeat the procedure for the other side of the closed circuit if so configured. The PCOR or PC regulator must operate at the same start pressure as noted previously. Any noticeable difference in operation from side to side may indicate a problem with the pressure supply shuttle spool or brake pressure defeat spool in the multi-function block.

NOTE: Some motors may be configured for the PCOR or PC regulator to function on only one (1) side of the closed loop. Refer to the nomenclature on the motor nameplate.

In order for the PCOR or PC regulator to function properly on motors equipped with a brake pressure defeat spool, the defeat spool must be positioned correctly. The control pressure for the defeat spool should be applied to the appropriate port (XA or XB) as shown in the following table to shift the defeat spool and permit PCOR or PC regulator operation. Maximum pressure across the brake pressure defeat ports XA and XB is 50 bar (725 psi).

Pressure Compensator Override Defeat Operation

Rotation	High system pressure port	Control pressure on port
CW	A	XB
CCW	B	XA

The PCOR or PC regulator valve is screw adjustable. To adjust, loosen the locknut with a 1-1/16" hex wrench. Turn the adjusting screw with a large screwdriver until the desired pressure setting is established. Clockwise rotation of the adjustment screw will increase the pressure setting at a rate of approximately 70 bar (1000 psi) per turn.

CAUTION

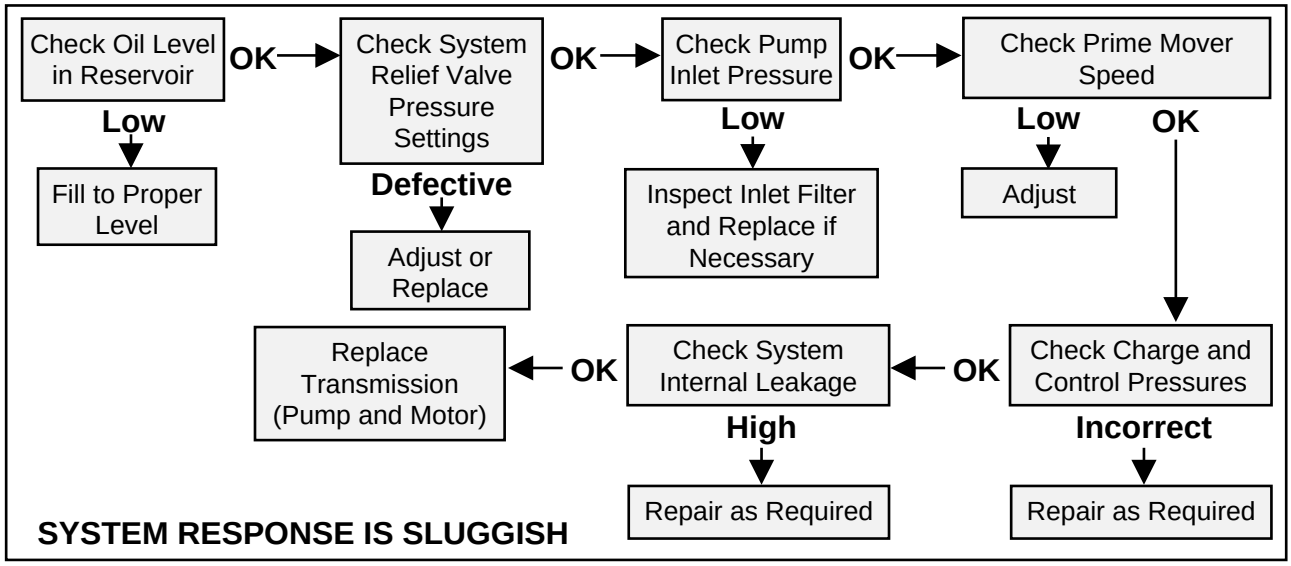
A stop pin is installed in the adjusting screw to prevent "overtravel" of the PCOR/PC valve spool. The stop pin must protrude (distance "X") 19 mm (.75 in.) from the spring seat for settings of 270 to 370 bar (3900 to 5350 psi), or 24 mm (.94 in.) for settings of 110 to 260 bar (1600 to 3750 psi). Refer to the appropriate Service Parts Manual for further information.

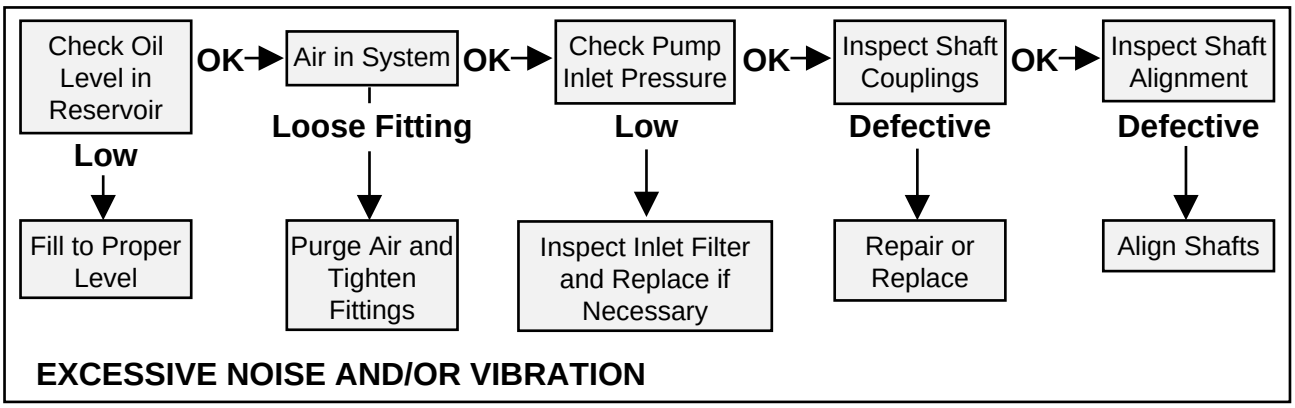
While holding the adjusting screw from turning, torque the lock nut to 52 Nm (38 ft•lbsf). Recheck the PCOR or PC regulator setting.

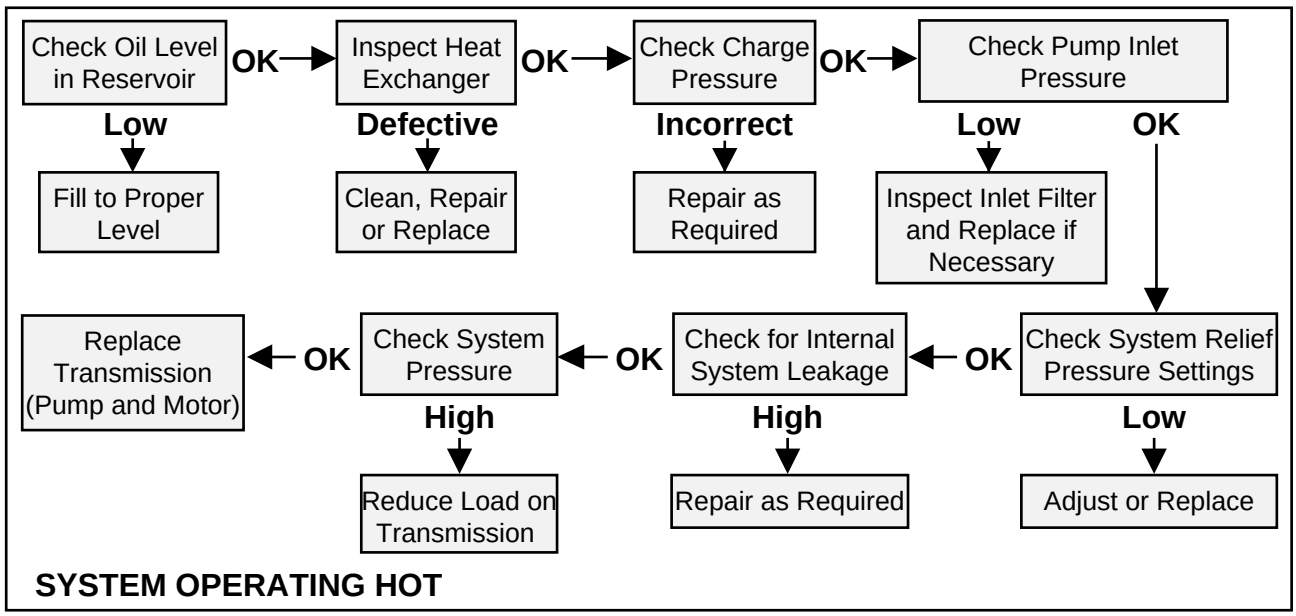
Shut down the prime mover. Remove the gauges and install the gauge port plugs. Return the pump and motor controls to their normal operation.

Troubleshooting

Fault-Logic Diagrams • Closed Circuit

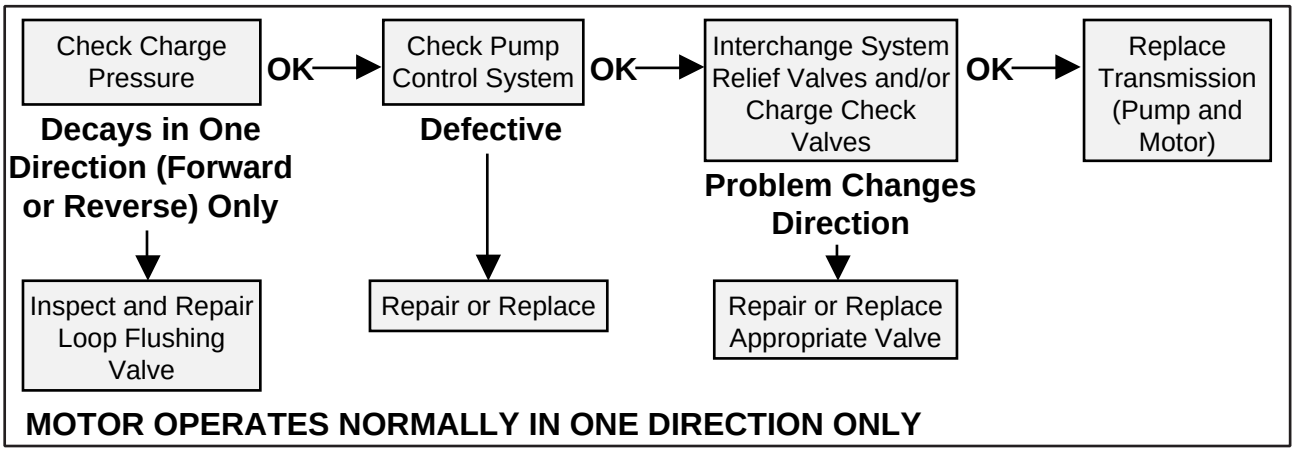


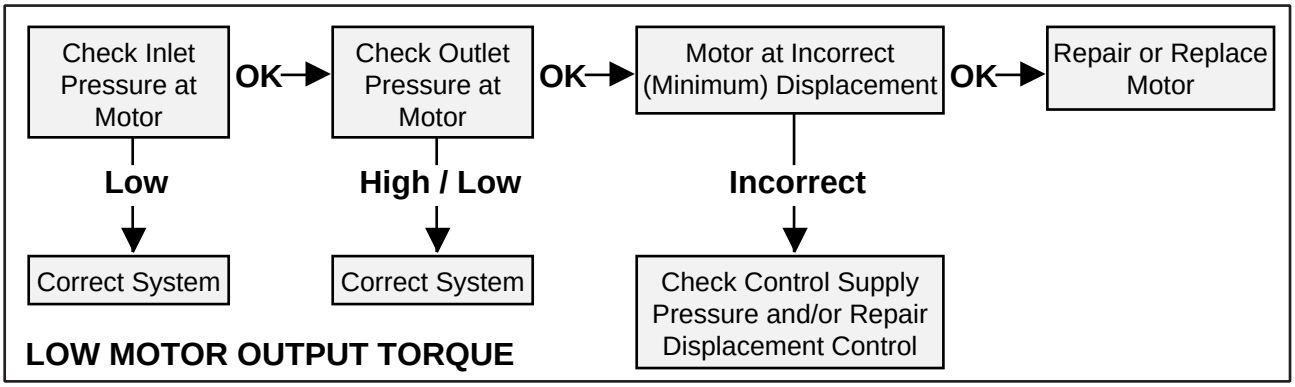


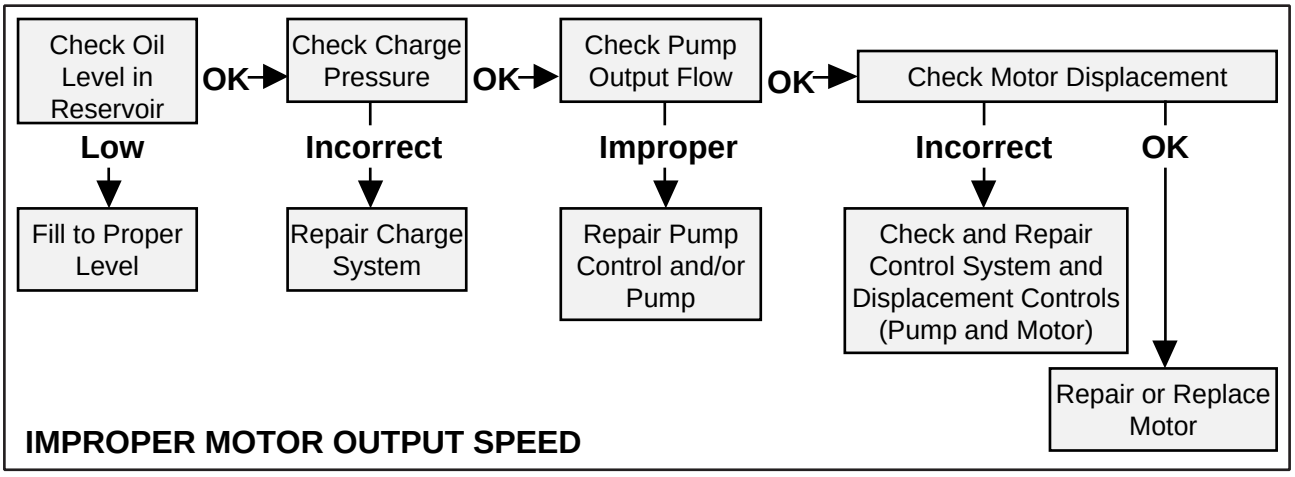


Troubleshooting (Continued)

Fault-Logic Diagrams • Closed Circuit (Continued)


Check Charge Pressure
OK
Check Pump Control System
OK
Interchange System Relief Valves and/or Charge Check Valves
OK
Replace Transmission (Pump and Motor)
Decays in One Direction (Forward or Reverse) Only
Defective
Problem Changes Direction
Inspect and Repair Loop Flushing Valve
Repair or Replace
Repair or Replace Appropriate Valve
MOTOR OPERATES NORMALLY IN ONE DIRECTION ONLY





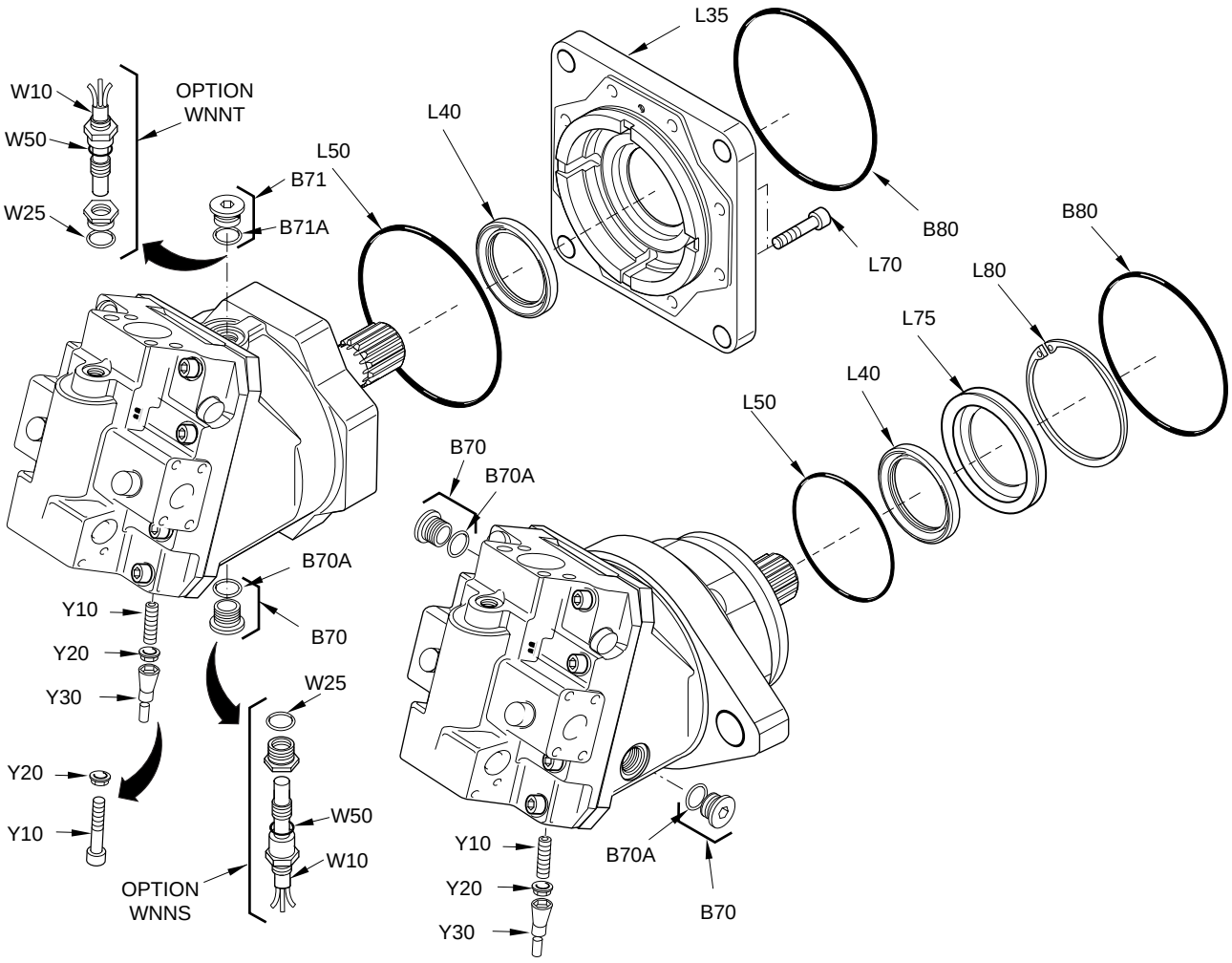
Notes

Notes

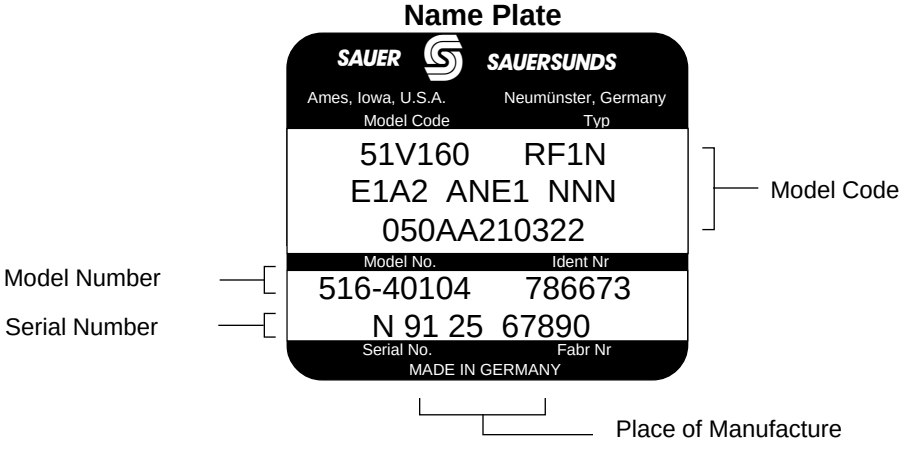
Exploded View of the Series 51 Variable Motor

The following information is for general parts identification ONLY. Refer to the applicable Service Parts List when ordering service parts.

Base Unit



Name Plate

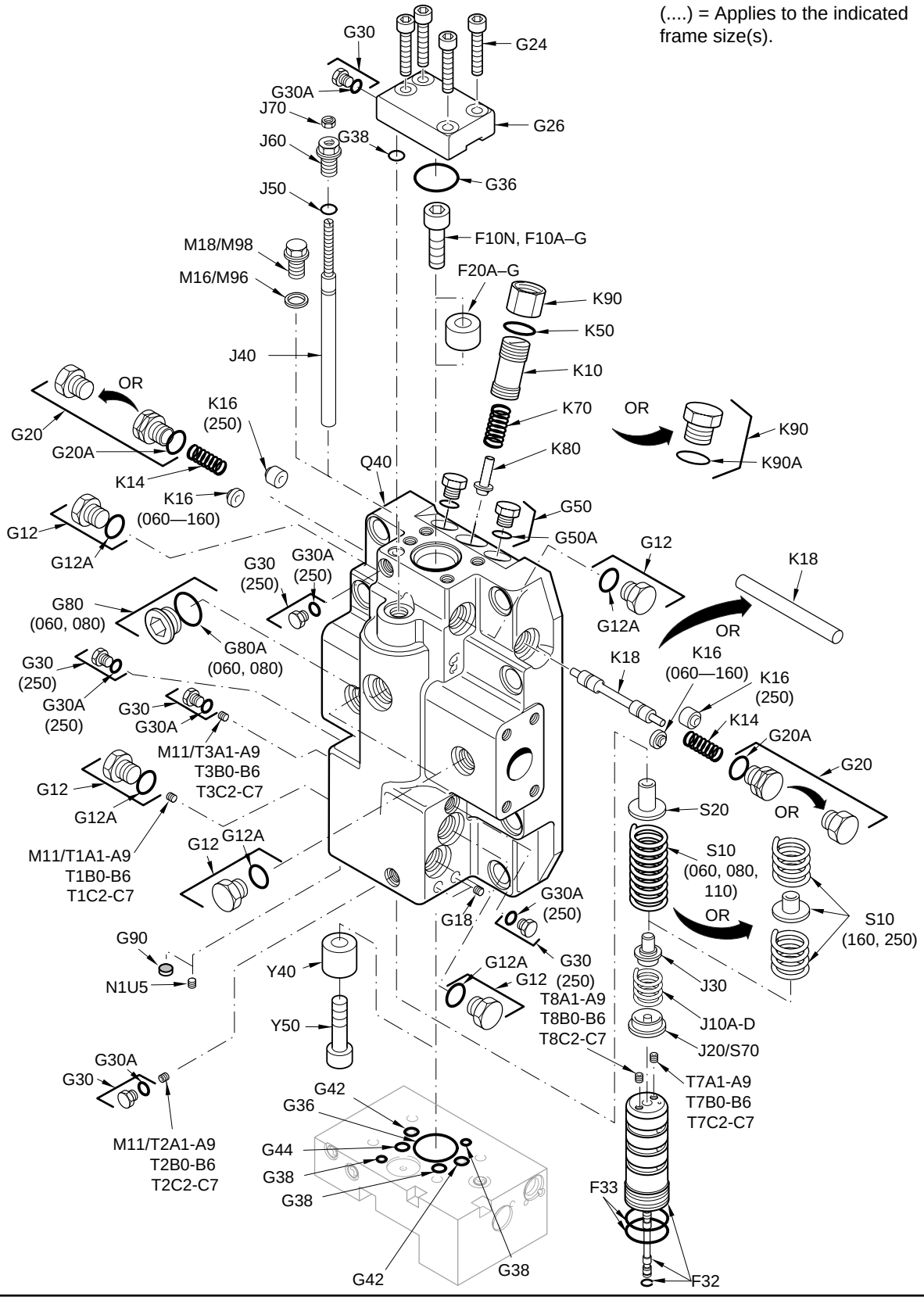


Name Plate (German Production)

Exploded View of the Series 51 Variable Motor (Continued)

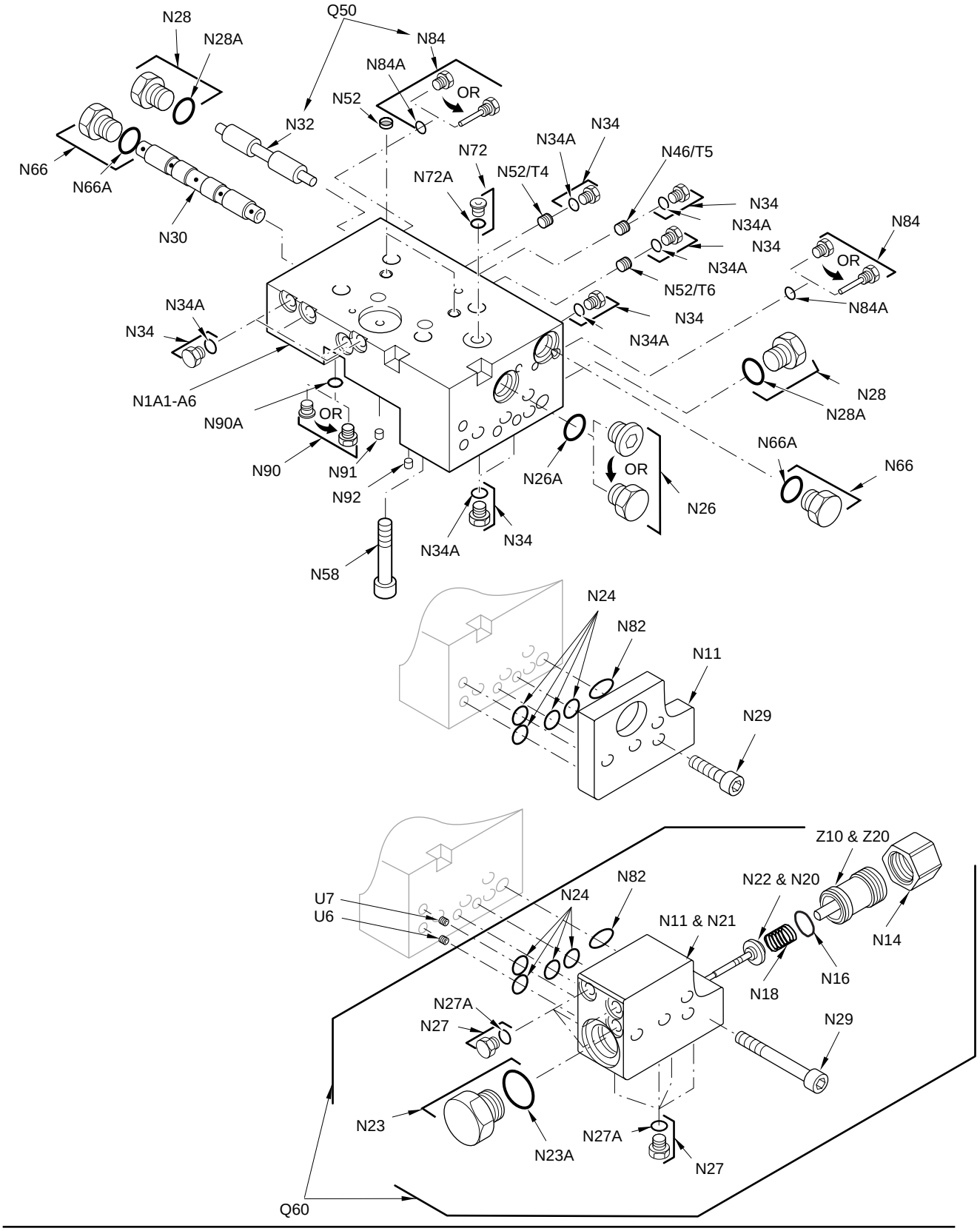
End Cap

(....) = Applies to the indicated frame size(s).



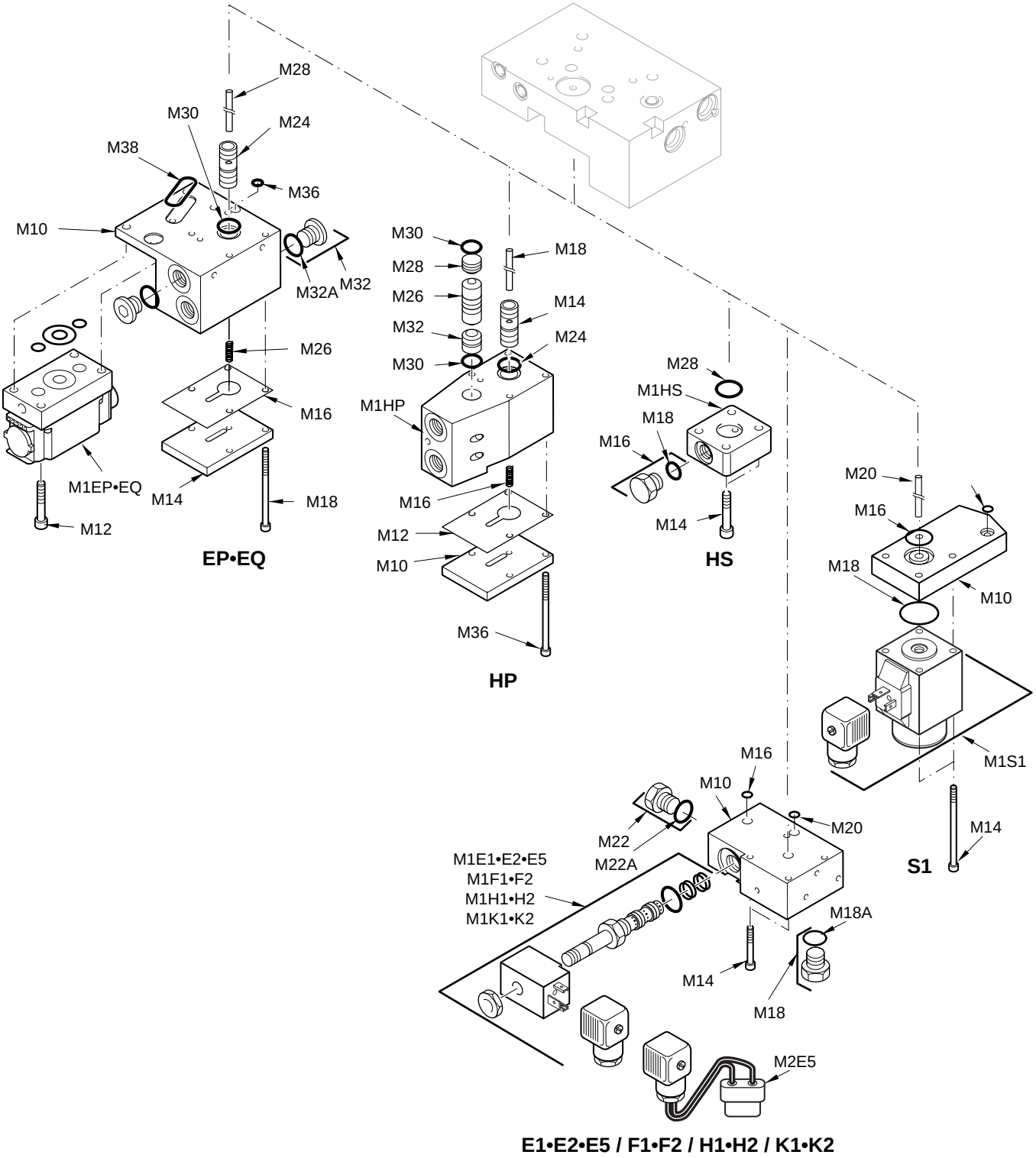
Exploded View of the Series 51 Variable Motor (Continued)

Multi-Function Block



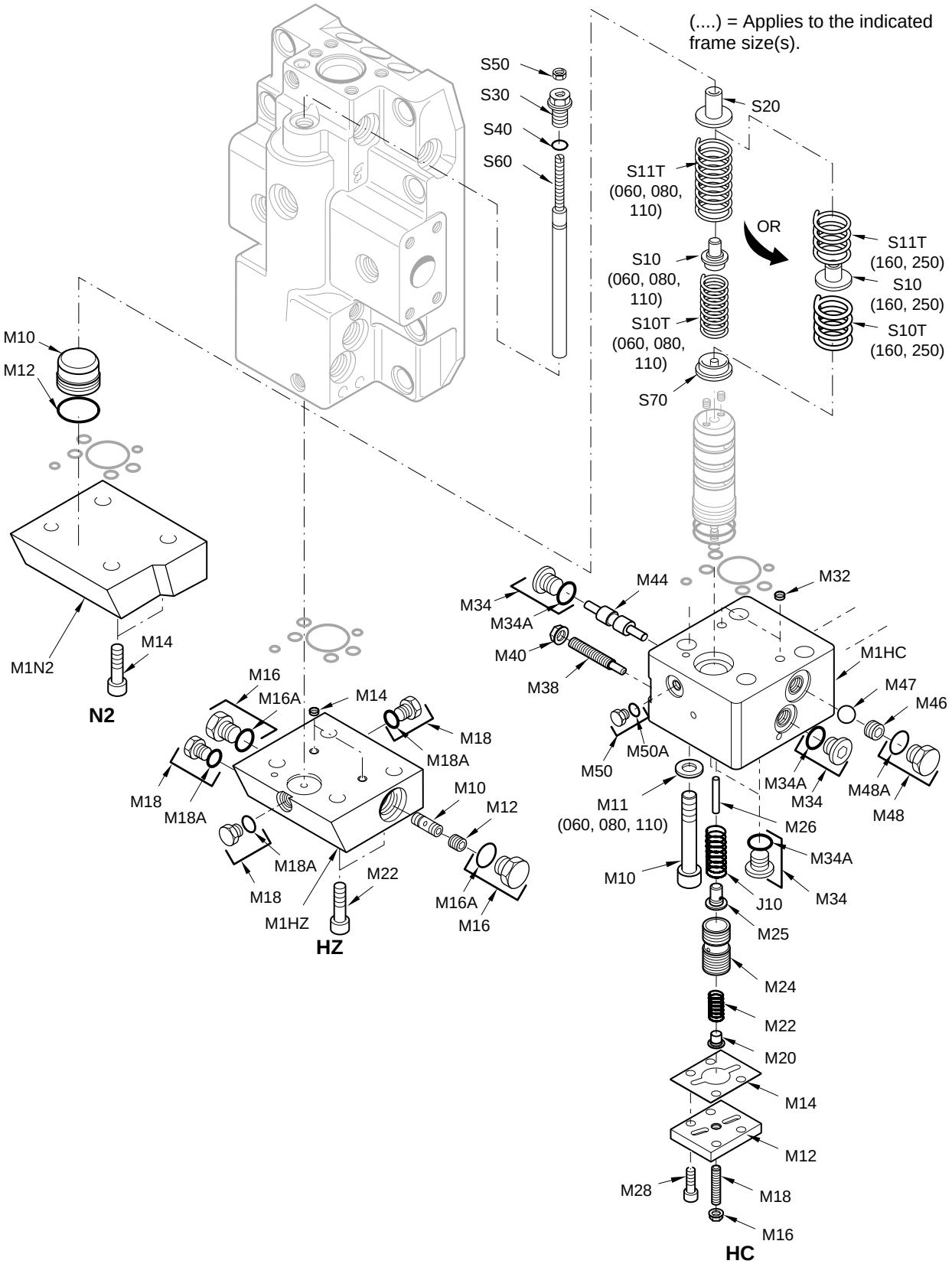
Exploded View of the Series 51 Variable Motor (Continued)

Controls



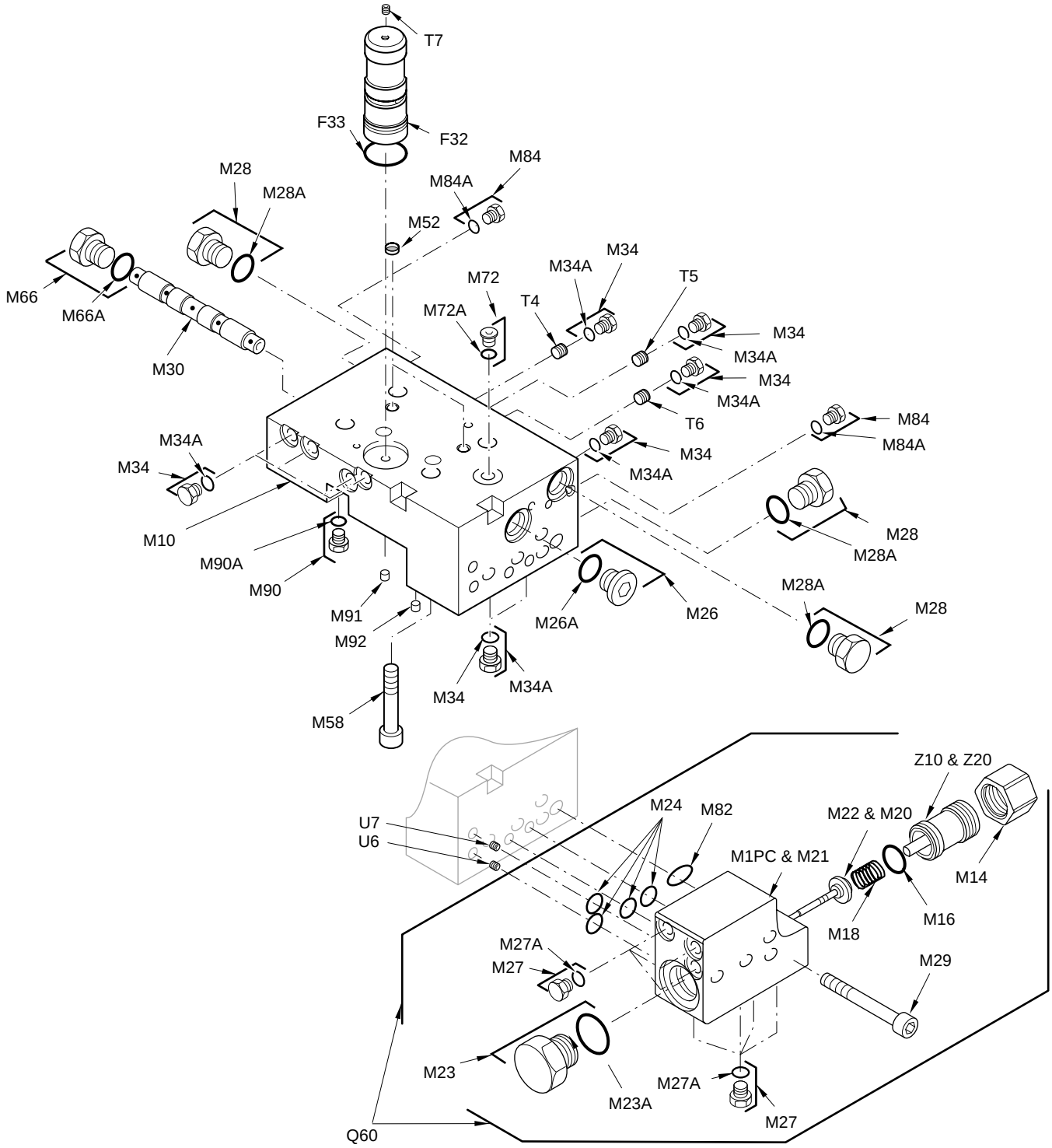
Exploded View of the Series 51 Variable Motor (Continued)

Controls (Continued)



Exploded View of the Series 51 Variable Motor (Continued)

PC Regulator



Exploded View of the Series 51 Variable Motor (Continued)

Item	Description	Quantity
B000	**COMMON PARTS GROUP (SAE FLNG)**	
B80	O-RING	1
L35	FLANGE- SAE	1
L40	SEAL- SHAFT	1
L50	O-RING	1
L70	SCREW- SOC HD	8
C000	**COMMON PARTS GROUP (CARTRIDGE)**	
L40	SEAL- SHAFT	1
L50	O-RING	1
L75	COVER- SEAL	1
L80	RING- RETAINING	1
F•••	**MAXIMUM DISPLACEMENT**	
F10	SPACER- MAX DISPL LMTR	1
F20	SCREW-SOC HD - MAX DISPL LMTR	1
G00A	**END CAP-AXIAL (160-250)**	
G00B	**END CAP-AXIAL, CODE 61 (160-250)**	
G00R	**END CAP-SIDE, LOOP FL**	
G00S	**END CAP-SIDE, LOOP FL, CODE 61**	
G12	PLUG-STR THD HEX	7
G14	PLUG-EXP	1
G16	PLUG-MANDREL	2
G18	SCREW-SET, FLAT PT	2
G20	PLUG- SPECIAL	2
G20N	PLUG- STR THD HEX	2
G24	SCREW-SOC HD	4
G26	COVER-SERVO PISTON	1
G30	PLUG-STR THD HEX	3
G36	O-RING	2
G38	O-RING	4
G42	O-RING	2
G44	O-RING	1
G50	PLUG-ST THD HEX	2
G70	COVER-PORT	2
G90	CONTROL SCREEN FILTER	1
K10	ADJ PLUG ASSY-CHG RLF	1
K14	SPRING-HELICAL COMP	2
K16	GUIDE-SPRING (060 — 160)	2
K16	GUIDE-SPRING (250)	2
K18	SHUTTLE VALVE SPOOL	1
K18N	LOOP FLUSH SPOOL- DEFEAT	1
K50	O-RING	1
K70	SPRING-HELICAL COMPRESSION	1
K80	POPPET-CHG RELIEF	1
K90	NUT-HEX LOCK	1
K90N	PLUG- ST THD HEX	1

Item	Description	Quantity
J00A-K	**CONTROL START SETTING**	
J10A-K	SPRING-HEL COMP- CONT START	1
J20	SEAT-SPRING	1
J30	SEAT-SPRING	1
J40	SCREW-ADJUSTING	1
J50	O-RING	1
J60	NUT-ADJUSTING SCREW	1
J70	NUT-LOCK	1
J00N	**CONT START N/A (FOR 2 POS CONT)**	
M0EP	**CONTROL- ELHYD PRP, PACKARD**	
M0EQ	**CONTROL- ELHYD PRP, MS**	
F32	BUSHING- VALVE ASSY	1
M1EP	PCP VALVE, PACKARD CONN	1
M1EQ	PCP VALVE, MS CONN	1
M10	HOUSING- CONTROL	1
M12	SCREW- SOC HD	4
M14	COVER	1
M16	GASKET	1
M18	SCREW- SOC HD	4
M24	PISTON- SHUTTLE, DELTA P	1
M26	SPRING- HEL COMPRESSION	1
M28	PIN	1
M30	O-RING	1
M32	PLUG-SOC HD	2
M34	PLUG-MANDREL	6
M36	O-RING	1
M38	O-RING	1
M40	CONTROL SCREEN FILTER	1
M42	PLUG-SOC HD	1
M44	PLUG-PLASTIC	1
M91	PLUG-EXP	1
N90	PLUG-STR THD HEX	1
M0E1/E2	**CONTROL- ELHYD 2 POS**	
M0F1/F2	**CONTROL- ELHYD 2 POS, MAX ANG**	
F32	BUSHING- VALVE ASSY	1
M1E1	VALVE ASSY- SOLENOID,12V	1
M1E2	VALVE ASSY- SOLENOID,24V	1
M10	HOUSING-CONT, ELHYD, 2 POS (E)	1
M10	HOUSING-CONT, ELHYD, 2 POS (F)	1
M12	PLUG-EXP	7
M14	SCREW-SOC HD	4
M16	O-RING	2
M18	PLUG-STR THD HEX	1
M20	O-RING	1
M22	PLUG-STR THD HEX	1
N90	PLUG-STR THD HEX	1

Exploded View of the Series 51 Variable Motor (Continued)

Item	Description	Quantity
M0HC	**CONTROL- HYD PRPNL 2LN, DUAL PATH**	
F32	BUSHING- VALVE ASSY	1
M1HC	HOUSING- HYD PRPNL (2LN),DUAL	1
M10	SCREW-SOC HD	4
M11	WASHER, FLAT (060, 080, 110)	4
M12	COVER	1
M14	GASKET	1
M16	NUT-SEAL LOCK	1
M18	SCREW-SET, FL PT	1
M20	GUIDE- SPRING	1
M22	SPRING-HELICAL COMPRESSION	1
M24	PISTON- DELTA P	1
M25	SEAT- SPRING	1
M26	PIN	1
M28	SCREW-SOC HD	4
M32	CONTROL SCREEN FILTER	2
M34	PLUG-SOC HD	4
M38	VALVE- BLEED	1
M40	NUT- SEAL LOCK	1
M44	VALVE, SHUTTLE- DELTA P	1
M46	SEAT- BALL CHECK	1
M47	BALL- SHUTTLE	1
M48	PLUG-STR THD HEX	1
M50	PLUG-STR THD HEX	1
M0HP	**CONTROL- HYD PRPNL 2LN, W/BLD**	
F32	BUSHING- VALVE ASSY	1
M1HP	HOUSING- HYD PRPNL (2LN),W/BLD	1
M10	COVER	1
M12	GASKET	1
M14	PISTON-SHUTTLE, DELTA P	1
M16	SPRING-HELICAL COMPRESSION	1
M18	PIN	1
M24	O-RING	1
M26	VALVE SHUTTLE,DELTA P	1
M28	PLUG-SEALING	1
M30	O-RING	2
M32	PLUG-SEALING	1
M34	PLUG-EXP	6
M36	SCREW-SOC HD	4
N90	PLUG-STR THD HEX	1
N91	PLUG-EXP	1
N92	PLUG-EXP	1

Item	Description	Quantity
M0HS	**CONTROL- HYD PRP, 1 LN**	
F32	BUSHING-VALVE ASSY	1
M1HS	HOUSING- VALVE, HYD PRPRNL 1 LN	1
M10	SCREW-SOC HD	4
M12	O-RING	1
M14	PLUG-STR THD HEX	1
M16	PLUG-PLASTIC	1
N90	PLUG-STR THD HEX	1
N91	PLUG-EXP	1
N92	PLUG-EXP	1
M0HZ	**CONTROL- HYD PRP, 1 LN, CMPCT**	
F32	BUSHING- VALVE ASSY	1
M1HZ	HOUSING- VALVE, HYD PRP, 1 LN, CPT	1
M10	VALVE ASSY- DBL CHECK	1
M12	SCREW- SOC- DRILLED	1
M14	CONTROL SCREEN FILTER	2
M16	PLUG-STR THD HEX	2
M18	PLUG-STR THD HEX	3
M0H1/H2	**CONTROL- HYD PRP, 1 LN, MAX ANG**	
M0K1/K2	**CONTROL- HYD PRP, 1 LN, MIN ANG**	
F32	BUSHING-VALVE ASSY	1
M1H1	VALVE ASSY-SOLENOID,12V	1
M1H2	VALVE ASSY-SOLENOID,12V	1
M10	HSG-CONT,ELHYD, 2 POS	1
M12	PLUG-EXP	8
M14	SCREW-SOC HD	4
M16	O-RING	2
M18	PLUG-STR THD HEX	1
M20	O-RING	1
M22	PLUG-PLASTIC	1
N90	PLUG-STR THD,SOC HD	1
N91	PLUG-EXP	1
M0N2	**CON-HYD, 2 POS, DIRECT**	
M1N2	COVER	1
M10	PLUG	1
M11	SCREW- SET,FLT PT	3
M12	O-RING	1
M14	SCREW-SOC	4
M16	GASKET	1
M18	PLUG	1

Exploded View of the Series 51 Variable Motor (Continued)

Item	Description	Quantity
M0PC	**REGULATOR- PRESS COMP**	
F32	PLUG- VALVE BUSHING BORE	1
F33	O-RING	1
M1PC	HOUSING- VALVE	1
M10	HOUSING- MULTI FUNCTION BLOCK	1
M14	NUT-HEX LOCK	1
M16	O-RING	1
M18	SPRING-HELICAL COMPRESSION	1
M20	SEAT-SPRING, PC	1
M21	BUSHING-VALVE	1
M22	SPOOL-PC VALVE	1
M23	PLUG-STR THD HEX	1
M26	PLUG-SOC HD	1
M27	PLUG-STR THD HEX	10
M28	PLUG-STR THD HEX	4
M29	SCREW-SOC	4
M30	SPOOL, BI-DIRECTIONAL CHECK	1
M34	PLUG-STR THD HEX	10
M36	SCREW-SET,FLT PT	5
M38	PLUG-EXP	11
M50	PLUG-EXP	8
M52	CONTROL SCREEN FILTER	2
M54	PLUG-EXP	1
M58	SCREW-SOC HD	4
M62	PLUG-EXP	1
M66	PLUG-STR THD HEX	2
M72	PLUG-STR THD,SOC HD	1
M82	O-RING	1
M84	PLUG-STR THD HEX	2
M86	SCREW-FL PT	1
M90	PLUG-STR THD HEX	1
M91	PLUG-EXP	1
M92	PLUG-EXP	1
M96	GASKET	1
M98	PLUG	1
N24	O-RING	5
M0S1	**CONTROL- ELECTRIC 2 POS, DIRECT**	
F32	BUSHING- VALVE ASSY	1
M1S1	SOLENOID,12V	1
M10	ADAPTER PLATE- SOLENOID	1
M14	SCREW-SOC HD	4
M16	O-RING	1
M18	O-RING	1
M20	PIN	1
M??	O-RING	1
N90	PLUG-STR THD HEX	1
N91	PLUG-EXP	1

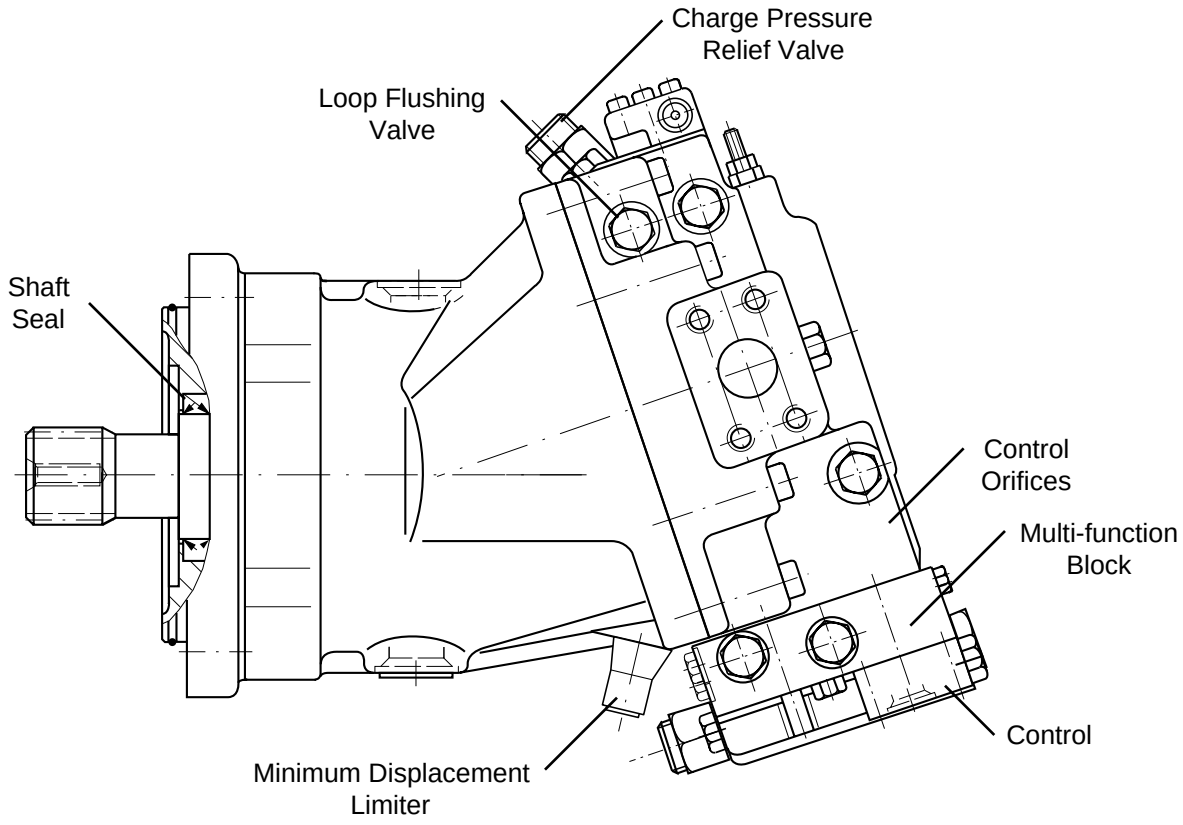
Item	Description	Quantity
N0A1-6	**SVO PRS SPLY, PCOR, DFT**	
N1A1-6	HOUSING-MULTI FUNCTION BLOCK	1
N11	HOUSING-VALVE	1
N14	NUT-HEX LOCK	1
N16	O-RING	1
N18	SPRING-HELICAL COMPRESSION	1
N20	SEAT-SPRING, PCOR	1
N21	BUSHING-VALVE	1
N22	SPOOL-PCOR VALVE	1
N23	PLUG-STR THD HEX	1
N24	O-RING	5
N26	PLUG-SOC HD (W/PCOR)	1
N26	PLUG-STR THD HEX (WO/PCOR)	1
N27	PLUG-STR THD HEX	17
N28	PLUG-PLASTIC (W/DFT)	2
N28	PLUG-STR THD HEX (WO/DFT)	2
N29	SCREW-SOC	4
N30	SPOOL, BI-DIRECTIONAL CHECK	1
N32	PISTON	1
N34	PLUG-STR THD HEX	10
N36	SCREW-SET,FLT PT	5
N38	PLUG-EXP (060 - 110 ONLY)	11
N50	PLUG-EXP (060 - 110 ONLY)	6
N52	CONTROL SCREEN FILTER	2
N54	PLUG-EXP	1
N58	SCREW-SOC HD	4
N62	PLUG-EXP	1
N66	PLUG-STR THD HEX (060-110)	2
N66	PLUG-STR THD HEX (160-250)	1
N72	PLUG-STR THD,SOC HD	1
N74	SCREW-SET, FL PT	3
N82	O-RING	1
N84	PLUG, SPECIAL	2
N84	PLUG-STR THD HEX	2
N86	SCREW-SET	1
U5	PLUG- SOC (EXT SUPPLY)	1
U6	ORIFICE, PCOR DAMPING	1
U7	ORIFICE, PCOR DAMPING	1
N0NN	**SERVO PRESS SPLY- NONE**	
P0AA	**SYS PRESS PROTECT- NONE**	

Exploded View of the Series 51 Variable Motor (Continued)

Item	Description	Quantity
S00D-G	**CONTROL RAMP- HP, HS, H1/H2, K1/K2**	
S10	GUIDE-SPRING (160-250)	1
S10D-G	CONT RAMP SPRING (060-110)	1
S10D-G	CONT RAMP SPRING ASSY (160-250)	2
S20	GUIDE-SPRING	1
S70	SEAT-SPRING	1
S00N	**CONTROL RAMP-NONE**	
S00T	**CONTROL RAMP- HC**	
S10	GUIDE-SPRING	1
S10T	CONT RAMP SPRING	1
S11T	CONT RAMP SPRING	1
S20	GUIDE-SPRING	1
S30	NUT- ADJUSTING SCREW	1
S40	O-RING	1
S50	NUT- LOCK	1
S60	SCREW- ADJUSTING	1
S70	SEAT-SPRING	1
S00U-Z	**CONTROL RAMP- EP/EQ**	
S10	GUIDE-SPRING (160-250)	1
S10U-Z	CONT RAMP SPRING (060-110)	1
S10U-Z	CONT RAMP SPRING ASSY (160-250)	1
T0A0	**CON ORIFICE (A0)- NONE**	
T0A1	**CON ORIFICE (A1)**	
T1	ORIFICE	1
T2	ORIFICE	2
T3	ORIFICE	1
T4	SCREW	2
T5	ORIFICE	1
T6	SCREW	1
T7	ORIFICE	2
T8	ORIFICE	1
U3	SCREW-FL PT	1
T0A2	**CON ORIFICE (A2)**	
T1	ORIFICE	1
T2	ORIFICE	2
T3	ORIFICE	1
T4	ORIFICE	2
T5	SCREW	1
T6	ORIFICE	1
T7	ORIFICE	2
T8	ORIFICE	1
WNNN	**SPCL HDW-NONE**	
A10	SPEED SENSOR 51V	0
B70	PLUG-SOC HD	1
B71	PLUG-PLASTIC	1

Item	Description	Quantity
Y•••	**MINIMUM DISPLACEMENT**	
Y10	SCREW- SET, FLT PT	1
Y20	NUT- HEX, SEAL LOCK	1
Y30	TAMPER RESISTANT CAP	1
Z000	**PRS COMP SET- NONE**	
Z0••	**PCOR / PRESS COMP SETTING**	
Z10	ADJUSTER- THREADED	1
Z20	PIN-STRAIGHT	1

Minor Repair and Replacement - Variable Motor



Variable Displacement Motor (SAE Flange Configuration)

Fig. 50-1 - Minor Repairs

Minor Repairs may be performed, following the procedures in this section, without voiding the unit warranty. Although specific products are illustrated, these procedures apply to all units in the Series 51 family.

General

Cleanliness is a primary means of insuring satisfactory transmission life, on either new or repaired units. Cleaning parts by using a solvent wash and air drying is adequate, providing clean solvent is used. As with any precision equipment, the internal mechanism and related items must be kept free of foreign materials and chemicals.

Protect all exposed sealing surfaces and open cavities from damage and foreign material.

It is recommended that all gaskets and O-rings be replaced. All gasket sealing surfaces must be cleaned prior to installing new gasket. Lightly lubricate all O-rings with clean petroleum jelly prior to assembly.

Minor Repair and Replacement - Variable Motor (Continued)

51000178

Fig. 50-2 - Remove Screws Holding Flange to Housing (SAE)

51000179

Fig. 50-3 - Remove Flange (SAE)

51000053

Fig. 50-4 - Remove Old Seal from Flange (SAE)

51000054

Fig. 50-5 - New Seal Installed in Flange (SAE)

Shaft Seal (SAE Flange Configuration)

Lip type shaft seals are used on the Series 51 motors.

Replacement of the shaft seal usually requires removal of the motor from the machine.

Remove the screws holding the flange to the housing, using a 6 mm internal hex wrench (060 and 080 units), an 8 mm internal hex wrench (110 units), a 10 mm internal hex wrench (160 units), or a 12 mm internal hex wrench (250 units).

Remove the flange from the housing using a suitable puller. Care must be taken so as to not damage the housing bore or shaft.

CAUTION

Do not allow the output shaft to move out of the housing while removing the flange. After the flange is removed, do not attempt to remove the shaft from the housing. If the output shaft moves out of the housing, the synchronizing shaft and rollers could fall out of position, requiring major disassembly of the unit.

Remove the old seal from the flange. Once removed, the seal is not reusable.

Inspect the flange and the new seal for any damage or nicks.

Using an arbor press, press the new seal into the flange. Be careful not to damage seal.

NOTE: The outside diameter of the seal may be lightly coated with a sealant (such as Loctite High Performance Sealant #59231) prior to installation. This will aid in preventing leaks caused by damage to the seal bore in the flange.

Inspect the sealing area on the shaft for rust, wear, or contamination.

Minor Repair and Replacement - Variable Motor (Continued)

Install a new O-ring on the flange. Prior to assembly, lubricate the flange O-ring and the I.D. of the seal with petroleum jelly.

Protect the seal lip from damage during installation by wrapping the spline or key end of shaft with plastic film, or by using a seal installation tool.

Assemble the flange and seal over the shaft and into the housing bore. Install four (4) of the flange screws, and tighten them evenly to pull the flange into position. Take care to not damage the O-ring or seal lip during installation.

Install the flange screws and torque evenly to 32 Nm (24 ft•lbsf) for 060 and 080 motors, 63 Nm (46 ft•lbsf) for 110 motors, 110 Nm (81 ft•lbsf) for 160 motors, and 174 Nm (128 ft•lbsf) for 250 motors.

Fig. 50-6 - Install Flange onto Housing (SAE)

Fig. 50-7 - Torque Flange Screws (SAE)

Shaft Seal (Cartridge Configuration)

Lip type shaft seals are used on the Series 51 motors. These seals can be replaced without major disassembly of the unit. However, replacement of the shaft seal requires removal of the motor from the wheel drive or track drive gearbox.

Remove the seal carrier retaining ring from the housing.

Carefully pull the seal cover out of the housing. Care must be taken so as not to damage the housing bore or shaft.

Remove the O-ring from the housing.

Remove the old seal from the carrier. Once removed, the seal is not reusable.

Inspect the carrier and the new seal for any damage or nicks.

Using an arbor press, press the new seal into the carrier. Be careful not to damage seal.

NOTE: The outside diameter of the seal may be lightly coated with a sealant (such as Loctite High Performance Sealant #59231) prior to installation. This will aid in preventing leaks caused by damage to the seal bore in the seal carrier.

Inspect the sealing area on the shaft for rust, wear, or contamination.

Fig. 50-8 - Remove Carrier Retaining Ring (Cartridge)

Fig. 50-9 - Remove Seal Carrier (Cartridge)

Fig. 50-10 - Seal Carrier Removed (Cartridge)

Fig. 50-11 - Seal Installed in Carrier (Cartridge)

Minor Repair and Replacement - Variable Motor (Continued)

51000061

Fig. 50-12 - Install Seal Carrier (Cartridge)

51000057

Fig. 50-13 - Install Carrier Retaining Ring (Cartridge)

Install the carrier O-ring into the groove in the housing. Prior to assembly, lubricate the carrier O-ring and the I.D. of the seal with petroleum jelly.

Protect the seal lip from damage during installation by wrapping the spline or key end of shaft with plastic film, or by using a seal installation tool.

Assemble the carrier and seal over the shaft and into the housing bore. Take care to not damage the O-ring or seal lip during installation.

Install the seal carrier retaining ring.

51000062

Fig. 50-14 - Remove Shuttle Valve Plugs

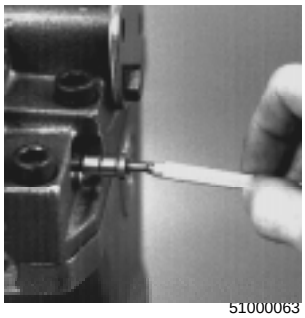

51000063

Fig. 50-15 - Remove Valve Spool

Loop Flushing Shuttle Valve (Option)

Using an 11/16" wrench, remove the hex plugs from both sides of end cap.

Remove springs and spring seat washers. Note the orientation of the washers.

NOTE The 250 frame size motors use thicker spring seat washers.

Remove flushing valve spool.

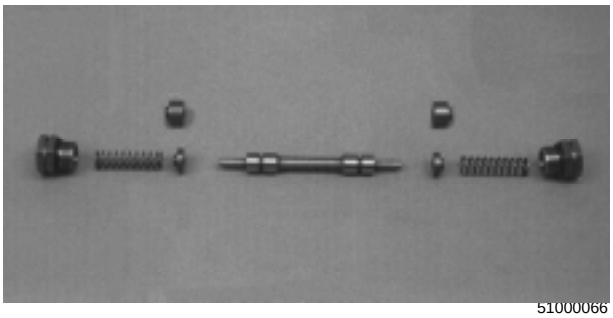

51000066

Fig. 50-16 - Loop Flushing Shuttle Valve Components

Inspect parts for damage or foreign material.

51000064

Fig. 50-17 - Install Valve Spool and Washers

51000065

Fig. 50-18 - Install Plugs and Springs

Install flushing valve spool in end cap, then install the spring seat washers (thick washers on 250 frame size motors) on each end of the spool. The step on the spring seat washers should face out, toward the springs.

Install the spool springs and hex plugs. Torque the plugs to 41 Nm (30 ft•lbsf).

Minor Repair and Replacement - Variable Motor (Continued)

Charge Pressure Relief Valve

Before removing the screw adjustable relief valve plug, mark the plug, lock nut, and end cap to allow maintaining the original adjustment when assembling. Remove the screw adjustable charge relief valve plug by loosening the lock nut (with a 1-1/16" hex wrench), and unscrewing the plug with a large screwdriver.

Remove the spring and relief valve poppet.

Inspect the poppet and mating seat in the end cap for damage or foreign material.

Install the poppet and spring. Install the plug with its lock nut, aligning the marks made at disassembly, and torque the lock nut to 52 Nm (38 ft•lbsf).

Check and adjust, if necessary, the charge pressure.

51000067

Fig. 50-19 - Remove Charge Relief Valve Plug

51000068

Fig. 50-20 - Remove Charge Relief Valve

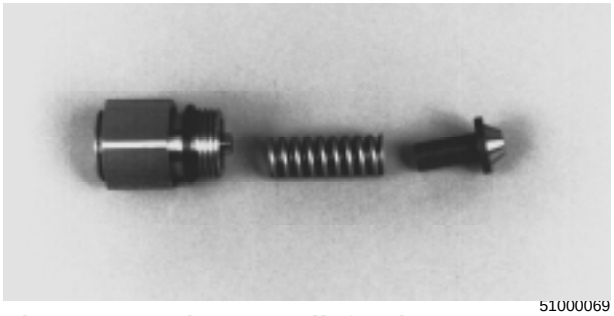

51000069

Fig. 50-21 - Charge Relief Valve Components

Minimum Angle Servo Cover

Thoroughly clean external surfaces prior to removal of cover.

Remove the four (4) screws retaining the cover to the end cap with an 8 mm internal hex wrench (060, 080, 110, and 160 units) or a 10 mm internal hex wrench (250 units). Remove the cover. Remove the O-rings between the cover and end cap.

Install new O-rings on the end cap and retain with petroleum jelly. Install the cover onto the end cap and install the screws. Torque the screws to 78 Nm (58 ft•lbsf) for 060, 080, or 110 units, or 110 Nm (81 ft•lbsf) for 160 or 250 units.

The plug in the cover may be removed with a 7/16" hex wrench. Torque this plug to 9 Nm (7 ft•lbsf).

51000046

Fig. 50-22 - Remove Servo Cover Screws

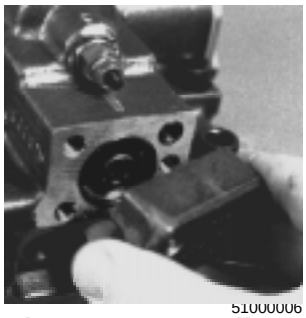

51000006

Fig. 50-23 - Install Servo Cover

Minor Repair and Replacement - Variable Motor (Continued)

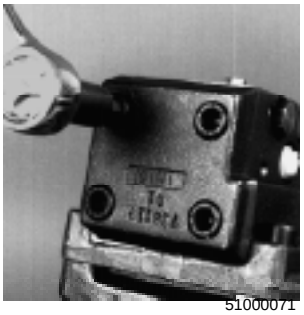


Fig. 50-24 - Remove Cover Plate Screws

Fig. 50-25 - Remove Cover Plate

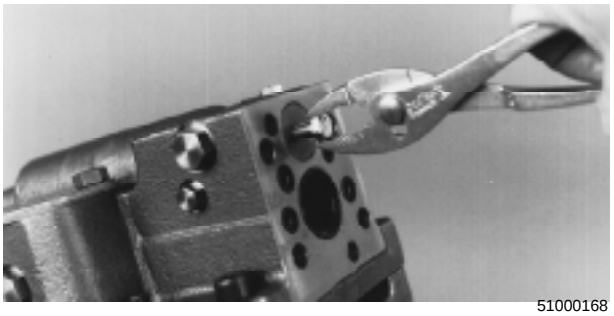


Fig. 50-26 - Remove Valve Sleeve Bore Plug

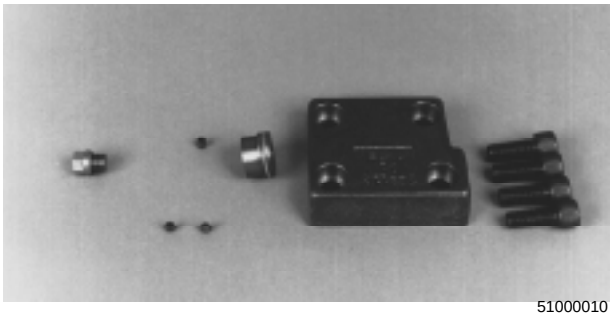


Fig. 50-27 - N2 Control Components

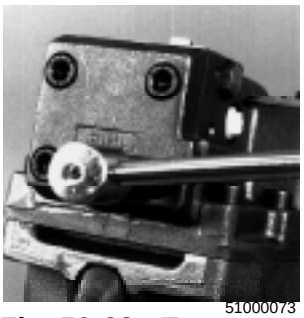


Fig. 50-28 - Torque Cover Plate Screws

Fig. 50-29 - Torque Plug in End Cap

Hydraulic 2-Position Control (Type N2)

Thoroughly clean external surfaces prior to removal of cover plate.

Remove the four (4) screws retaining the cover plate to the end cap with an 8 mm internal hex wrench (060, 080, and 110 units) or a 10 mm internal hex wrench (160 and 250 units). Remove the cover plate.

Remove the solid plug from the valve sleeve bore in the end cap. (An 8 mm threaded hole is provided in the plug for a puller screw.) Remove the O-ring from the plug.

Remove the O-rings from the end cap.

Install new O-rings on the end cap and retain with petroleum jelly.

Install a new O-ring on the solid plug and install the solid plug into the end cap.

Install the cover plate onto the end cap and install the screws. Torque the screws to 78 Nm (58 ft•lbsf) for 060, 080, or 110 units, or to 110 Nm (81 ft•lbsf) for 160 or 250 units.

Set screws are installed in control orifice holes in the end cap to plug the valve sleeve bore passages. To gain access to the screw plugs, remove the outer plugs from the end cap with a 7/16" or 11/16" hex wrench. Remove the screw plugs with a 3 mm internal hex wrench. When installing, torque the screw plugs to 4 Nm (35 in•lbsf). Torque the 5/16" outer plugs to 9 Nm (7 ft•lbsf), and the 9/16" outer plugs to 37 Nm (27 ft•lbsf). Refer to the “Control Orifices” topic for additional information.

The special plug and seal washer on the end cap opposite the control may be removed with a 13 mm hex wrench. When installing, torque this plug to 20 Nm (15 ft•lbsf).

Minor Repair and Replacement - Variable Motor (Continued)

Electrohydraulic 2-Position Controls (Types E1•E2 and F1•F2)

Thoroughly clean external surfaces prior to removing the control.

The solenoid may be removed from the valve by removing the nut with a 3/4" hex wrench. The solenoid valve may be removed from the control valve housing with a 7/8" hex wrench.

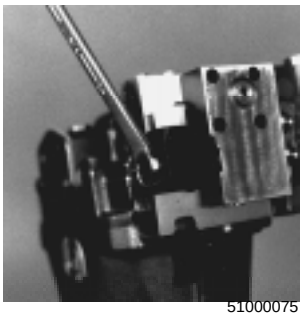


Fig. 50-30 - Remove E1•E2 or F1•F2 Control Solenoid

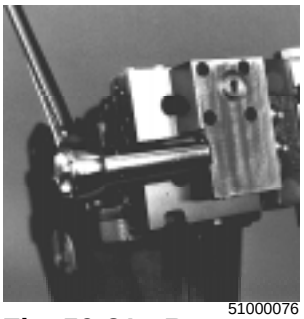


Fig. 50-31 - Remove Solenoid Valve

Remove the screws retaining the valve housing to the multi-function block with a 4 mm internal hex wrench. Remove the valve housing.

The plugs on the control housing may be removed with an 11/16" hex wrench. When reinstalling, torque the plugs to 37 Nm (27 ft•lbsf).

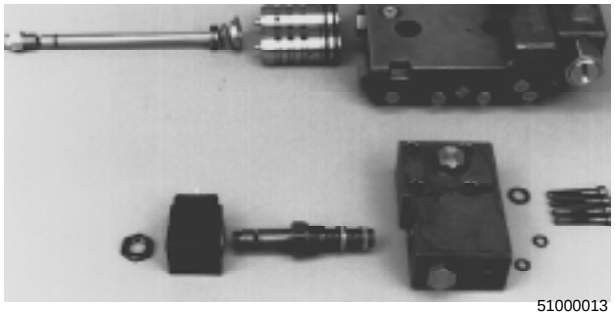


Fig. 50-32 - E1•E2 and F1•F2 Control Components

Install new O-rings onto the valve housing. Install the valve housing onto the multi-function block, and install the screws. Torque the screws to 6.4 Nm (4.7 ft•lbsf).

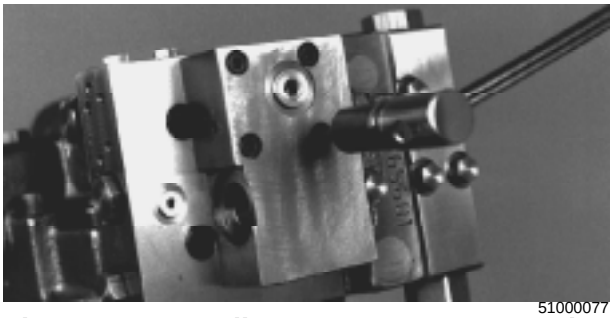


Fig. 50-33 - Install E1•E2 or F1•F2 Control Valve Housing

When installing the solenoid valve into the valve housing, the valve should be torqued to 20 Nm (15 ft•lbsf). When installing the solenoid onto the valve, torque the nut to 15 Nm (11 ft•lbsf.).

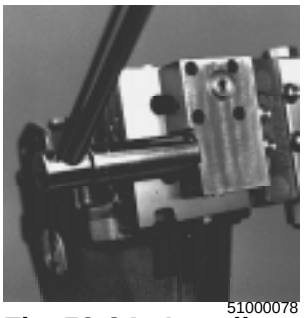


Fig. 50-34 - Install Solenoid Valve

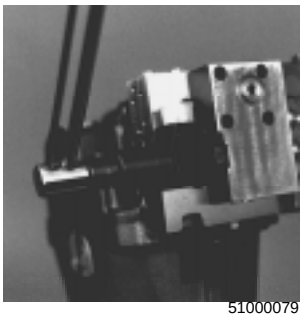


Fig. 50-35 - Install Solenoid

Minor Repair and Replacement - Variable Motor (Continued)

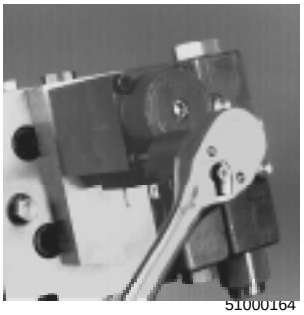


Fig. 50-36 - Remove S1 Control Screws

Fig. 50-37 - Remove Adapter Plate and Solenoid

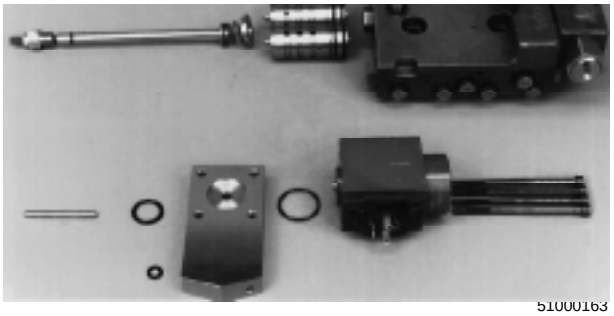


Fig. 50-38 - S1 Control Components

Electric 2-Position Controls (Type S1)

Thoroughly clean external surfaces prior to removing the control.

Remove the screws retaining the solenoid and solenoid adapter plate to the multi-function block with a 4 mm internal hex wrench. Remove the solenoid and the solenoid adapter plate from the multi-function block.

Remove the solenoid pin from the multi-function block.

Install new O-rings onto the adapter plate and the solenoid.

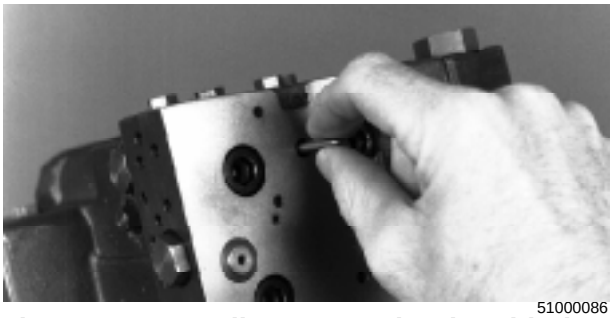


Fig. 50-39 - Install S1 Control Solenoid Pin

Install the solenoid pin into the hole in the multi-function block.

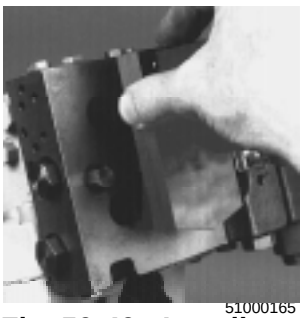


Fig. 50-40 - Install Adapter Plate and Solenoid

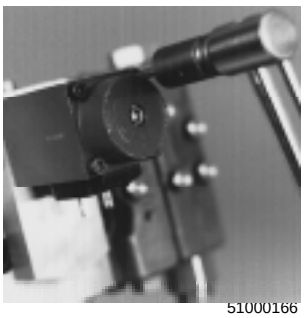


Fig. 50-41 - Torque Control Solenoid Screws

Install the adapter plate with O-rings onto the multi-function block.

Install the solenoid with O-ring onto the adapter plate.

Install the screws and torque to 6.4 Nm (4.7 ft•lbsf).

Minor Repair and Replacement - Variable Motor (Continued)

Hydraulic Proportional Control (Type HZ)

Thoroughly clean external surfaces prior to removal of control.

Remove the four (4) screws retaining the valve housing to the end cap with an 8 mm internal hex wrench (060, 080, and 110 units) or a 10 mm internal hex wrench (160 and 250 units). Remove the valve housing. Remove the O-rings between the valve housing and end cap, and the O-ring on the valve spool sleeve.

51000080

Fig. 50-42 - Remove HZ Control Housing Screws

51000081

Fig. 50-43 - Remove HZ Control Housing

The plugs on the control housing may be removed with a 7/16" or 11/16" hex wrench. When reinstalling, torque the 5/16" plugs to 9 Nm (7 ft•lbsf), and the 9/16" plugs to 37 Nm (27 ft•lbsf)

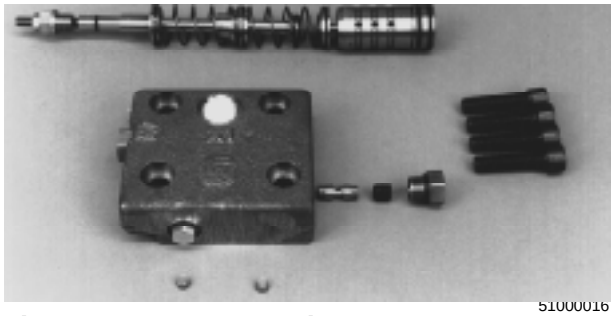

51000016

Fig. 50-44 - HZ Control Components

The valve housing is equipped with filter screens in the passages between the housing and the end cap. Units with internal servo pressure supply have a filter screen installed in the end cap passage leading to the valve spool sleeve. These screens should be pressed into position (with the rounded edge of the filter screens facing “out”) until they are flush to 2.0 mm (0.08 in.) below the machined surface of the valve housing or end cap.

Units with external servo pressure supply have a plug installed in the end cap passage leading to the valve spool sleeve. This plug may be removed with a 2.5 mm internal hex wrench. When installing this plug, torque to 2 Nm (18 in•lbsf).

Install a new O-ring onto the valve spool sleeve in the end cap. Install new O-rings onto the end cap.

Install the valve housing onto the multi-function block, and install the screws.

Torque the screws to 78 Nm (58 ft•lbsf) for 060, 080, or 110 units, or to 110 Nm (81 ft•lbsf) for 160 or 250 units.

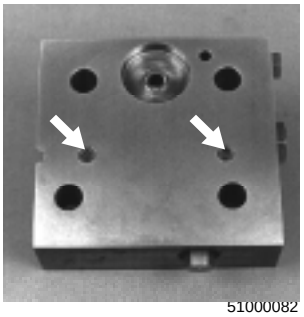

51000082

Fig. 50-45 - HZ Control Housing Screens

51000083

Fig. 50-46 - End Cap O-Rings Installed

51000081

Fig. 50-47 - Install HZ Control Housing

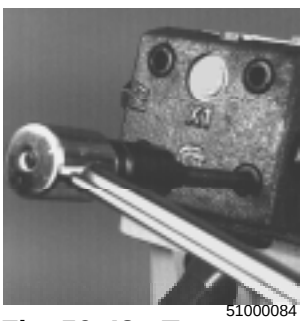

51000084

Fig. 50-48 - Torque HZ Control Valve Housing Screws

Minor Repair and Replacement - Variable Motor (Continued)

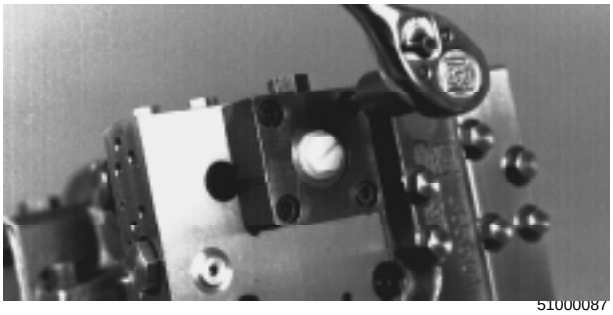


Fig. 50-49 - Remove HS Control Housing Screws

Hydraulic Proportional Control (Type HS)

Thoroughly clean external surfaces prior to removal of control.

Remove the screws retaining the valve housing to the multi-function block with a 4 mm internal hex wrench. Remove the valve housing.

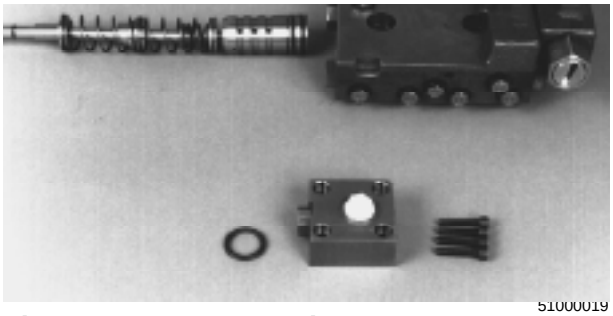


Fig. 50-50 - HS Control Components

The plug on the control housing may be removed with an 11/16" hex wrench. When reinstalling, torque the plug to 37 Nm (27 ft•lbsf).

Install a new O-ring onto the valve housing.

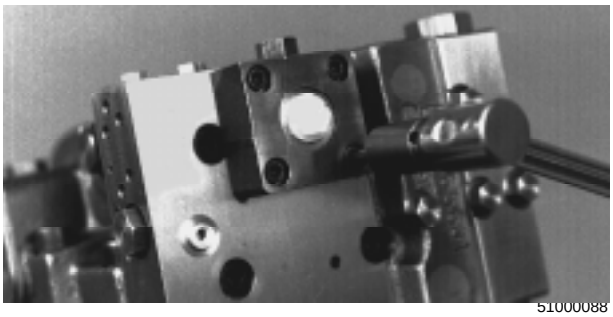


Fig. 50-51 - Torque HS Control Housing Screws

Install the valve housing onto the multi-function block, and install the screws.

Torque the screws to 6.4 Nm (4.7 ft•lbsf).

Minor Repair and Replacement - Variable Motor (Continued)

Hydraulic Proportional Control with Maximum Angle Over-ride (Types H1•H2 or K1•K2)

Thoroughly clean external surfaces prior to removing the control.

The solenoid may be removed from the valve by removing the nut with a 3/4" hex wrench.

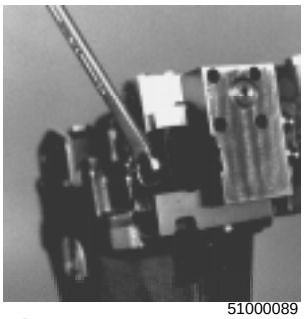

51000089

Fig. 50-52 - Remove H1•H2 or K1•K2 Control Solenoid

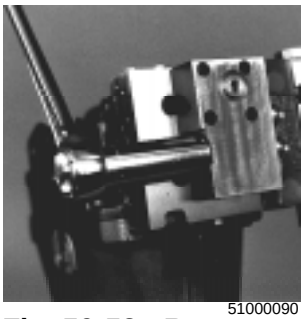

51000090

Fig. 50-53 - Remove Solenoid Valve

The solenoid valve may be removed from the control valve housing with a 7/8" hex wrench.

Remove the screws retaining the valve housing to the multi-function block with a 4 mm internal hex wrench. Remove the valve housing.

The plugs on the control housing may be removed with an 11/16" hex wrench. When reinstalling, torque the plugs to 37 Nm (27 ft•lbsf).

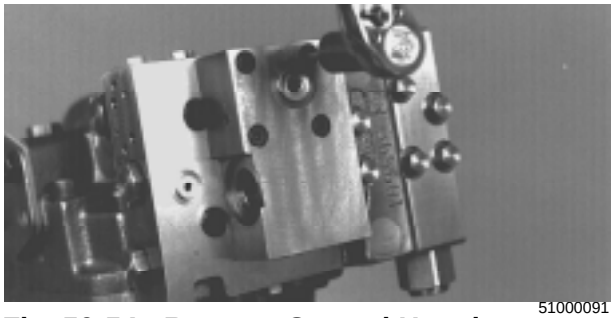

51000091

Fig. 50-54 - Remove Control Housing Screws

Install new O-rings onto the valve housing.

Install the valve housing onto the multi-function block, and install the screws. Torque the screws to 6.4 Nm (4.7 ft•lbsf).

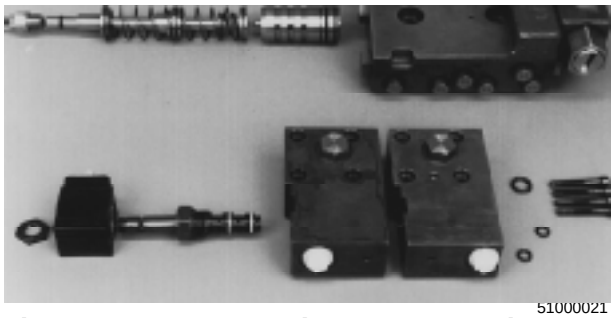

51000021

Fig. 50-55 - H1•H2 and K1•K2 Control Components

When installing the solenoid valve into the valve housing, the valve should be torqued to 20 Nm (15 ft•lbsf).

When installing the solenoid onto the valve, torque the nut to 15 Nm (11 ft•lbsf.).

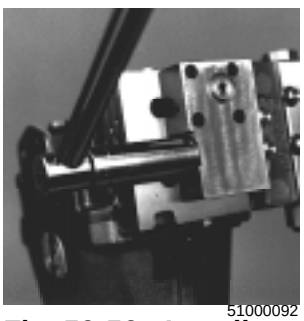

51000092

Fig. 50-56 - Install Solenoid Valve

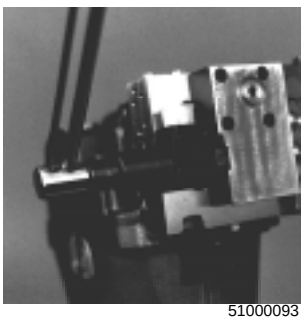

51000093

Fig. 50-57 - Install Solenoid

Minor Repair and Replacement - Variable Motor (Continued)

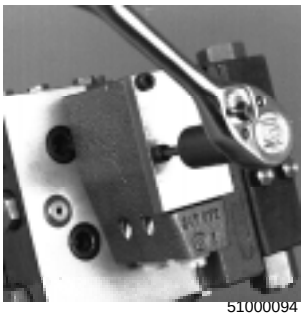

51000094

Fig. 50-58 - Remove HP Control Housing Screws

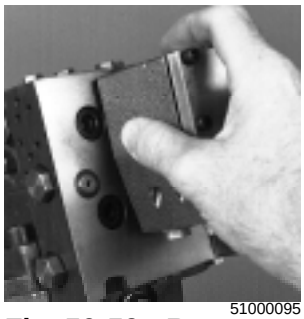

51000095

Fig. 50-59 - Remove Control Housing

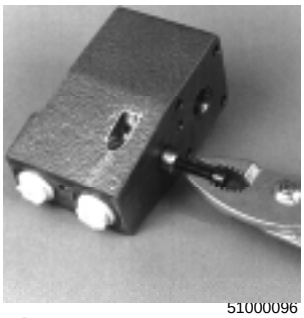

51000096

Fig. 50-60 - Remove Shuttle Spool Plug

51000086

Fig. 50-61 - Remove Pilot Piston Pin

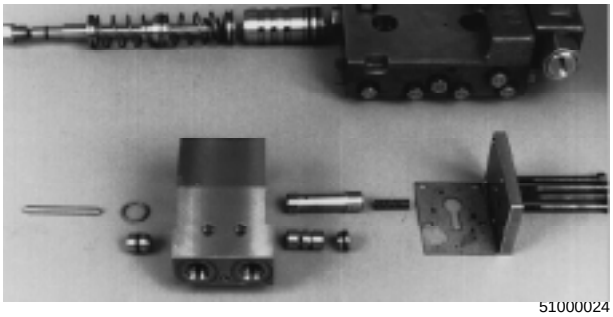

51000024

Fig. 50-62 - HP Control Components

Two Connection Hydraulic Proportional Control (Type HP)

Thoroughly clean external surfaces prior to removal of control.

Hold the control housing in position, and remove the screws retaining the cover and control housing to the multi-function block with a 4 mm internal hex wrench. Remove the housing cover and gasket. Remove the valve housing with shuttle valve assembly and pilot piston from the multi-function block.

Remove the O-rings from the valve housing. Remove the pilot piston and spring from the valve housing.

Remove the pilot piston pin from the multi-function block.

Remove the inner shuttle spool plug from the valve housing. (A 5 mm threaded hole is provided in the inner plug for a puller screw.) Remove the shuttle spool from the valve housing. Remove the outer shuttle spool plug. Remove the O-rings from the plugs.

Install new O-rings on the shuttle spool plugs.

Install new O-rings on the valve housing and retain with petroleum jelly.

Minor Repair and Replacement - Variable Motor (Continued)

Install the pilot piston pin in the multi-function block.

Install the outer (thin) shuttle piston plug with the large chamfer toward the shuttle valve bore. Install the shuttle spool into its bore and install the inner (thick) plug with the large chamfer toward the shuttle valve bore.

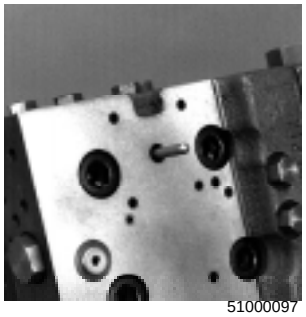

51000097

Fig. 50-63 - Pilot Piston Pin Installed

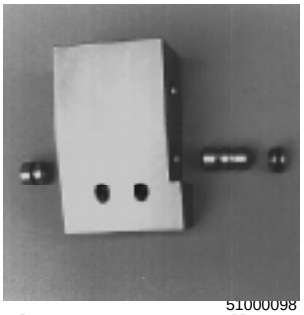

51000098

Fig. 50-64 - Install Shuttle Spool and Plugs

Position the valve housing (with O-ring) on the multi-function block.

Install the pilot piston into the housing and over the pin. The end of the piston with the cross drilled hole should engage the pin.

51000099

Fig. 50-65 - Install Control Housing

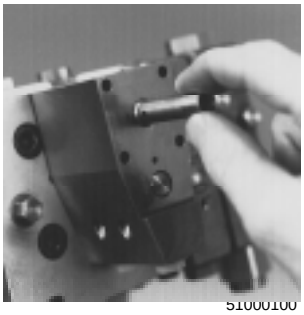

51000100

Fig. 50-66 - Install Pilot Piston

Install the small spring in the outer end of the pilot piston.

Install the control cover and gasket. Align the control assembly with the multi-function block and install the four (4) screws.

Torque the control screws to 6.4 Nm (4.7 ft•lbsf).

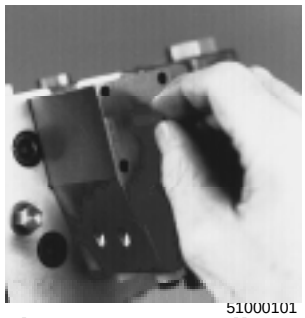

51000101

Fig. 50-67 - Install Spring

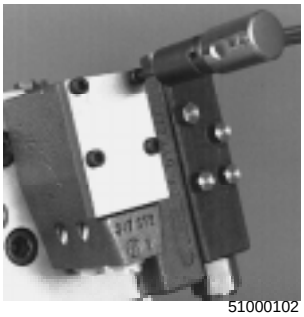

51000102

Fig. 50-68 - Install Cover, Gasket, and Screws

Minor Repair and Replacement - Variable Motor (Continued)

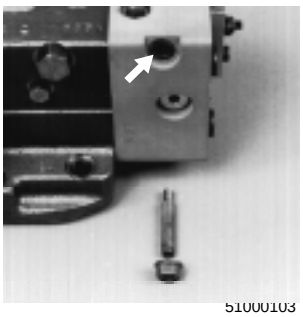


Fig. 50-69 - Remove HC Control Bleed Valve

Fig. 50-70 - Install HC Control Bleed Valve

Fig. 50-71 - Install HC Control Bleed Valve Seal Nut

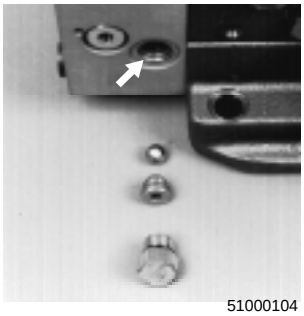


Fig. 50-72 - Remove Servo Pressure Ball Shuttle Valve

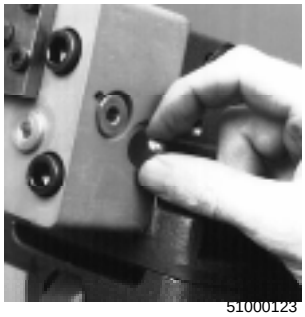


Fig. 50-73 - Install Servo Pressure Shuttle Ball Valve

Fig. 50-74 - Torque Servo Pressure Shuttle Ball Seat

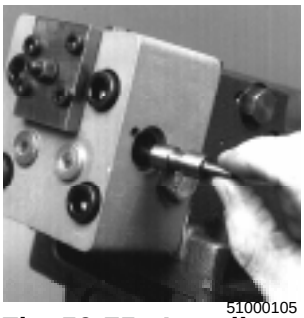


Fig. 50-75 - Install Control Pressure Shuttle Spool

Fig. 50-76 - Torque Shuttle Spool Plugs

Two Connection Hydraulic Proportional Control for “Dual Path” Vehicles (Type HC)

Bleed Valve

Loosen the seal lock nut on the bleed valve with a 10 mm hex wrench, and remove the valve with a 4 mm internal hex wrench.

Install the bleed valve and torque to 3 Nm (27 in•lbsf).

Install the seal lock nut and torque to 19 Nm (14 ft•lbsf).

Servo Pressure Shuttle Valve

Remove the servo pressure shuttle plug with an 11⁄16" hex wrench. Remove the shuttle ball seat with a 5 mm internal hex wrench and remove the ball.

Install the servo pressure shuttle ball.

Install the shuttle ball seat and torque to 11 Nm (8 ft•lbsf). Install the shuttle passage plug and torque to 37 Nm (27 ft•lbsf).

Control Pressure Shuttle Valve

Remove the shuttle spool plugs with a 1/4" internal hex wrench. Remove the control pressure shuttle spool.

Install the control pressure shuttle spool.

Install the shuttle spool plugs and torque to 20 Nm (15 ft•lbsf).

Minor Repair and Replacement - Variable Motor (Continued)

Pilot Piston and Control Housing

Thoroughly clean external surfaces prior to disassembly of control.

Remove the four (4) screws retaining the cover to the control housing with a 4 mm internal hex wrench.

Remove the housing cover and gasket (with the adjusting screw and seal lock nut).

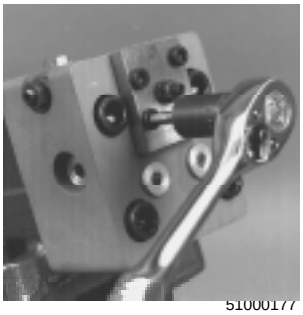


Fig. 50-77 - Remove HC Control Housing Cover Screws

Fig. 50-78 - Remove HC Control Housing Cover

Remove the control start adjustor spring seat and spring from the pilot piston.

Remove the pilot piston from the control housing.

Remove the pilot piston pin seat and pin from the control housing (or pilot piston).

Remove the control start spring from the control housing.

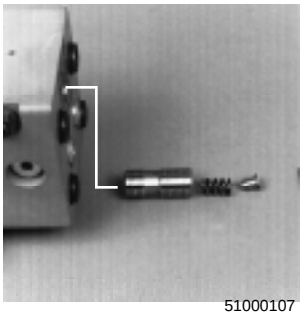


Fig. 50-79 - Remove Adjustment Spring and Pilot Piston

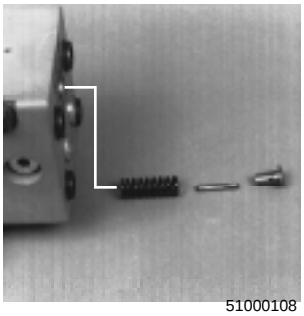


Fig. 50-80 - Remove Pilot Piston Pin and Control Start Spring

Remove the four (4) screws (and washers for 060, 080, and 110 units) retaining the control housing to the end cap with an 8 mm internal hex wrench (060, 080, and 110 units) or a 10 mm internal hex wrench (160 and 250 units).

Remove the control housing from the end cap. Remove the O-rings between the control housing and the end cap, and the O-ring on the valve spool sleeve.

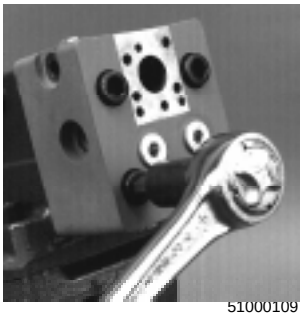


Fig. 50-81 - Remove HC Control Housing Screws

Fig. 50-82 - Remove HC Control Housing

Minor Repair and Replacement - Variable Motor (Continued)

51000111

Fig. 50-83 - HC Control Components

The plugs on the control housing may be removed with a 7/16" hex wrench or a 1/4" internal hex wrench. When reinstalling, torque the 5/16" plugs to 9 Nm (7 ft•lbsf), and the 9/16" plugs to 20 Nm (15 ft•lbsf).

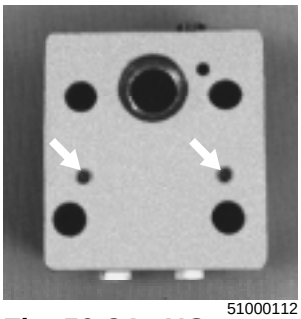

51000112

Fig. 50-84 - HC Control Housing Screens

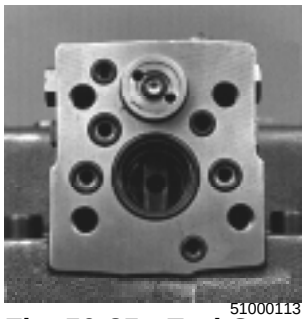

51000113

Fig. 50-85 - End Cap O-Rings Installed for HC Control

The control housing is equipped with filter screens in the passages between the housing and the end cap. Units with internal servo pressure supply have a filter screen installed in the end cap passage leading to the valve spool sleeve. These screens should be pressed into position (with the rounded edge of the filter screens facing “out”) until they are flush to 2.0 mm (0.08 in.) below the machined surface of the valve housing or end cap.

Install a new O-ring onto the valve spool sleeve in the end cap. Install new O-rings onto the end cap.

51000110

Fig. 50-86 - Install HC Control Housing

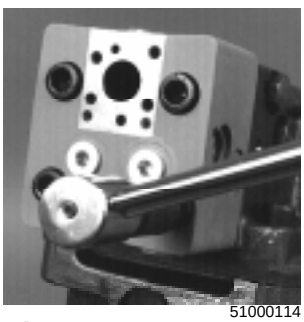

51000114

Fig. 50-87 - Torque HC Control Housing Screws

Install the valve housing onto the end cap, and install the screws (with flat washers on 060, 080, and 110 units).

Torque the screws to 78 Nm (58 ft•lbsf) for 060, 080, and 110 units, or to 110 Nm (81 ft•lbsf) for 160 and 250 units.

Minor Repair and Replacement - Variable Motor (Continued)

Install the control start spring into the control housing.

Install the pilot piston pin. The end of the pin must engage the recess in the end of the control valve spool.

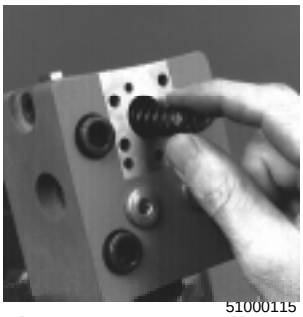


Fig. 50-88 - Install HC Control Start Spring

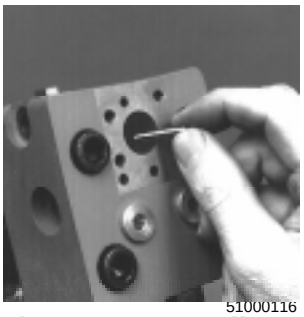


Fig. 50-89 - Install Pilot Piston Pin

Install the pilot piston pin seat.

Install the pilot piston into the housing and over the spring and spring seat. The end of the piston with the deeper bore and the cross drilled hole should engage the start spring and pin seat.

Fig. 50-90 - Install Pilot Piston Pin Seat

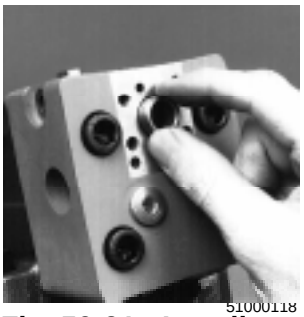


Fig. 50-91 - Install HC Control Pilot Piston

Install the adjustor spring in the outer end of the pilot piston.

Install the adjustor spring seat.

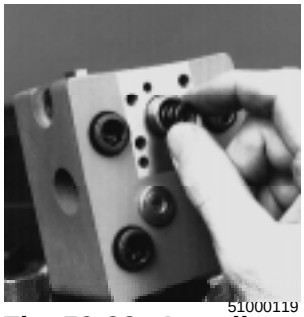


Fig. 50-92 - Install HC Control Start Adjuster Spring

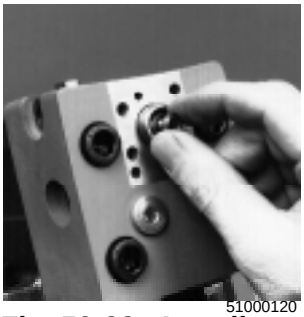


Fig. 50-93 - Install HC Control Start Adjuster Spring Seat

Install the control cover and gasket (with adjusting screw and seal lock nut).

Torque the control cover screws to 6.4 Nm (4.7 ft•lbsf).

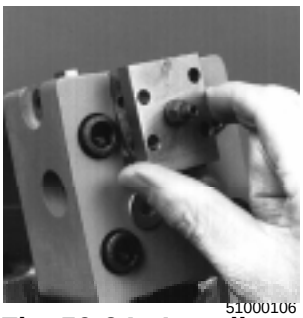


Fig. 50-94 - Install HC Control Cover and Gasket

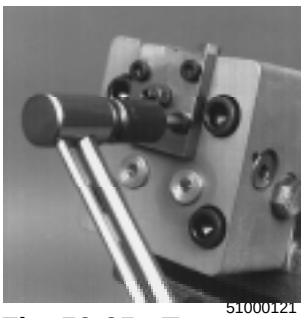


Fig. 50-95 - Torque Control Cover Screws

Minor Repair and Replacement - Variable Motor (Continued)

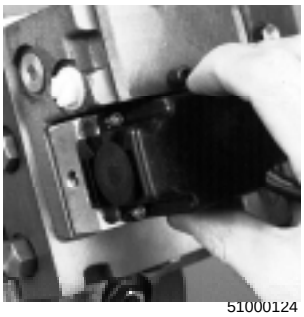

51000124

Fig. 50-96 - Remove PCP Valve

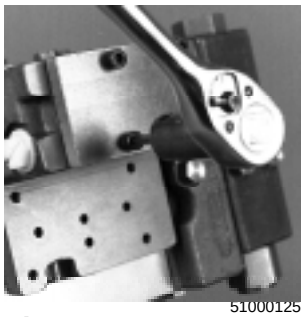

51000125

Fig. 50-97 - Remove EP•EQ Control Housing Screws

51000126

Fig. 50-98 - Remove EP•EQ Control Housing

51000086

Fig. 50-99 - Remove Pilot Piston Pin

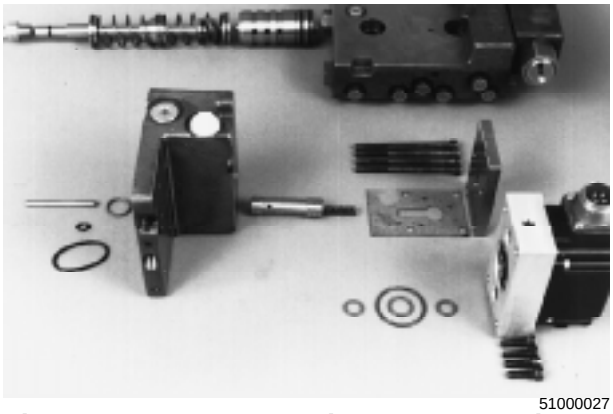

51000027

Fig. 50-100 - EQ Control Components (EP Similar)

Electrohydraulic Proportional Control (Types EP and EQ)

Thoroughly clean external surfaces prior to removal of control.

The Pressure Control Pilot (PCP) valve may be removed from the control valve housing, as described under the following heading.

Remove the screws retaining the control housing cover and control valve housing to the multi-function block with a 4 mm internal hex wrench. Remove the housing cover and gasket.

Remove the valve housing with the pilot piston from the multi-function block.

Remove the O-rings from the valve housing. Remove the pilot piston and spring from the valve housing.

Remove the pilot piston pin from the multi-function block.

Install new O-rings on the valve housing and retain with petroleum jelly.

The plugs on the control housing may be removed with a 1/4" internal hex wrench. When reinstalling, torque the 9/16" plugs to 20 Nm (15 ft•lbsf).

Minor Repair and Replacement - Variable Motor (Continued)

Install the pilot piston pin in the multi-function block.

Position the valve housing (with O-rings) on the multi-function block.

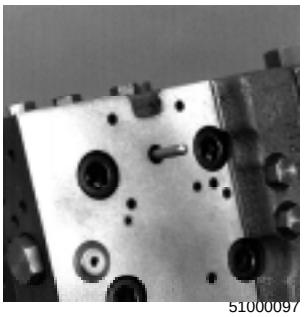


Fig. 50-101 - Pilot Piston Pin Installed

Fig. 50-102 - Install Control Housing

Install the pilot piston into the housing and over the pin. The end of the piston with the cross drilled hole should engage the pin.

Install the small spring in the outer end of the pilot piston.

Fig. 50-103 - Install Pilot Piston

Fig. 50-104 - Install Spring

Install the control cover and gasket. Align the control assembly with the multi-function block and install the four (4) screws.

Torque the control screws to 6.4 Nm (4.7 ft•lbsf).

Reinstall the PCP valve, if removed.

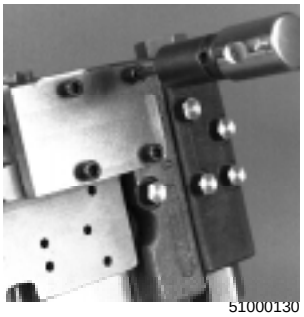


Fig. 50-105 - Torque Cover, Gasket, and Screws

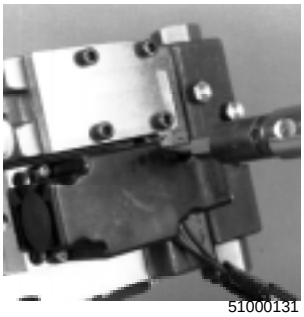


Fig. 50-106 - Install PCP Valve

Minor Repair and Replacement - Variable Motor (Continued)

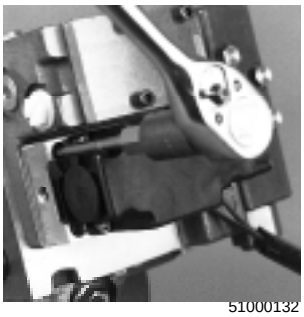


Fig. 50-107 - Remove PCP Valve Screws

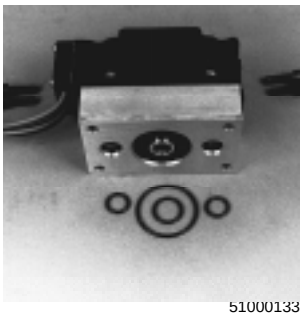


Fig. 50-108 - PCP Valve Components

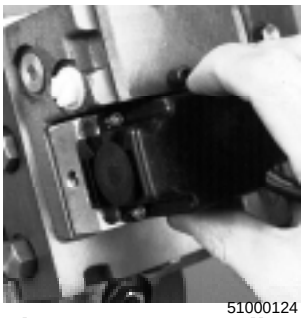


Fig. 50-109 - Install PCP onto Control

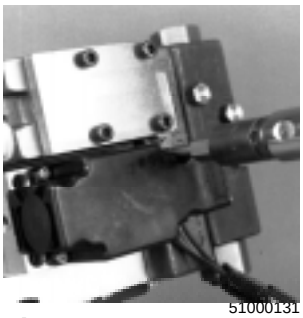


Fig. 50-110 - Torque PCP Valve Screws

Pressure Control Pilot (PCP) Valve for Electrohydraulic Proportional Control (Types EP and EQ)

Thoroughly clean external surfaces of control.

Using a 4 mm internal hex wrench, remove the four (4) screws and remove the PCP valve.

Check surfaces for nicks or damage. Clean internal screens.

Install new O-rings on the PCP housing and retain with petroleum jelly. Position the PCP on the control valve housing and install the screws.

Torque the screws to 5.4 Nm (48 in•lbsf).

Minor Repair and Replacement - Variable Motor (Continued)

Multi-function Block

Removal and Installation

Remove the external control assembly as described in the instructions for the specific control.

Remove the four (4) screws (and washers for 060, 080, and 110 units) retaining the multi-function block to the end cap with an 8 mm internal hex wrench (060, 080, and 110 units) or a 10 mm internal hex wrench (160 and 250 units).

Remove the multi-function block from the end cap. Remove the O-rings between the multi-function block and the end cap, and the O-ring on the valve spool sleeve.

The multi-function block is equipped with filter screens in the passages between the block and the end cap. Units with internal servo pressure supply have a filter screen installed in the end cap passage leading to the valve spool sleeve. These screens should be pressed into position (with the rounded edge of the filter screens facing “out”) until they are flush to 2.0 mm (0.08 in.) below the machined surface of the multi-function block or end cap.

Units with external servo pressure supply have a plug installed in the end cap passage leading to the valve spool sleeve. This plug may be removed with a 2.5 mm internal hex wrench. When installing this plug, torque to 2 Nm (18 in•lbsf).

Install a new O-ring onto the valve spool sleeve in the end cap.

Install new O-rings onto the end cap.

Install the multi-function block onto the end cap, and install the screws.

Torque the screws to 78 Nm (58 ft•lbsf) for 060, 080, or 110 units, or to 110 Nm (81 ft•lbsf) for 160 or 250 units.

Reinstall the external control assembly as described in the instructions for the specific control.

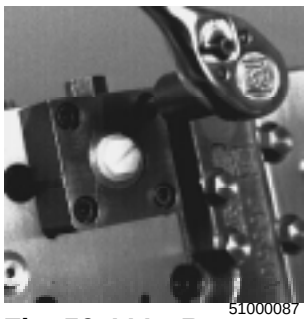

51000087

Fig. 50-111 - Remove External Control (HS Shown)

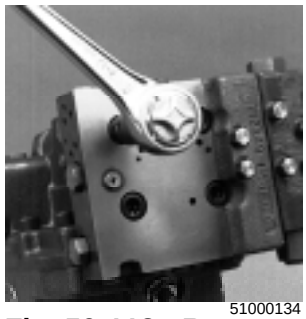

51000134

Fig. 50-112 - Remove Multi-function Block Screws

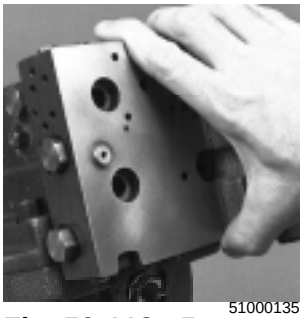

51000135

Fig. 50-113 - Remove Multi-function Block

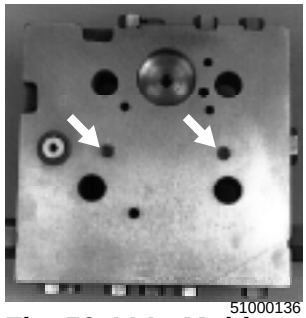

51000136

Fig. 50-114 - Multi-function Block Screens

51000083

Fig. 50-115 - End Cap O-Rings Installed

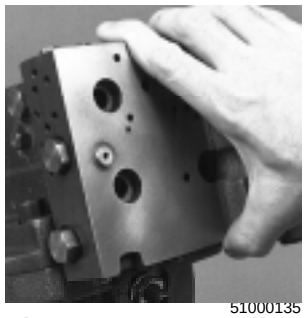

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Fig. 50-116 - Install Multi-function Block

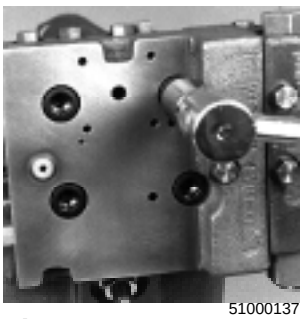
51000137

Fig. 50-117 - Torque Multi-function Block Screws

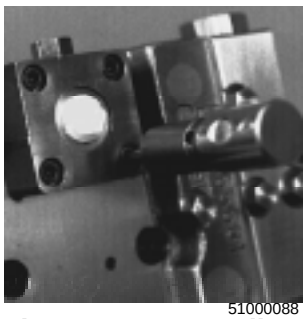
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Fig. 50-118 - Install External Control (HS Shown)

Minor Repair and Replacement - Variable Motor (Continued)

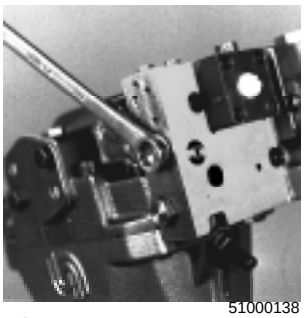

Fig. 50-119 - Remove Servo Pressure Supply Spool Plug

Fig. 50-120 - Remove Servo Pressure Supply Shuttle Spool

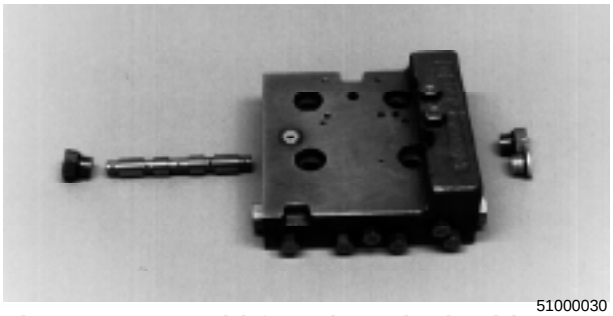

Fig. 50-121 - Multi-function Block with Servo Pressure Supply Shuttle Spool

Servo Pressure Supply Shuttle Spool

Remove the servo pressure supply shuttle spool plug from the multi-function valve with a 9/16" hex wrench.

NOTE: If a pressure compensator valve block is installed, the opposite end of the shuttle spool bore in the multi-function valve is plugged with an internal hex head plug located under the valve block. If a pressure compensator valve block is not installed, the opposite end of the shuttle spool bore is plugged with a hex head plug.

Remove the servo pressure supply shuttle spool from the multi-function valve block.

Inspect the shuttle spool for burrs or scoring. The spool must slide free in its bore. The shuttle ball in the spool must be free to move.

Fig. 50-122 - Install Servo Pressure Supply Shuttle Spool

Fig. 50-123 - Torque Servo Pressure Supply Spool Plug

Install the shuttle spool into the multi-function block.

Install the hex head plug into the multi-function valve and torque to 37 Nm (27 ft•lbsf).

NOTE: If an internal hex head plug was removed from the opposite end of the shuttle spool bore, torque it to 20 Nm (15 ft•lbsf).

Minor Repair and Replacement - Variable Motor (Continued)

Blocking Plate for Multi-function Block Without PCOR

The blocking plate may be removed by removing the four (4) screws with a 5 mm internal hex wrench. Remove the O-rings from the plate.

Install new O-rings on the blocking plate and retain with petroleum jelly. Install the plate on the multi-function block and install the screws. Torque the screws to 11 Nm (8 ft•lbsf).

51000170

Fig. 50-124 - Remove Blocking Plate (Less PCOR)

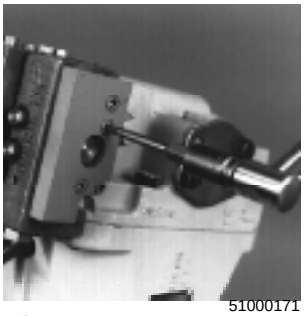
51000171

Fig. 50-125 - Torque Blocking Plate Screws (Less PCOR)

Pressure Compensator Valve for Pressure Compensator Over-Ride (PCOR) and Pressure Compensator Regulator (Type PC)

Loosen the adjusting screw lock nut with a 1-1/16" hex wrench. Remove the adjusting screw from the valve block with a large screwdriver.

Remove the pressure compensator valve spring and the spool assembly from the block.

51000142

Fig. 50-126 - Remove PCOR•PC Adjustor

51000143

Fig. 50-127 - Remove PCOR•PC Spring and Spool Valve

Remove the valve block plug with a 1" hex wrench.

Remove the four (4) screws retaining the valve block to the multi-function block with a 5 mm internal hex wrench. Remove the valve block and O-rings.

51000144

Fig. 50-128 - Remove PCOR•PC Plug

51000145

Fig. 50-129 - Remove PCOR•PC Valve Block

Install new O-rings on the pressure compensator valve block and retain with petroleum jelly. Install a new O-ring on the adjusting screw.

The plugs on the valve block may be removed with a 7⁄16" hex wrench. When reinstalling, torque the 5⁄16" plugs to 9 Nm (7 ft•lbsf).

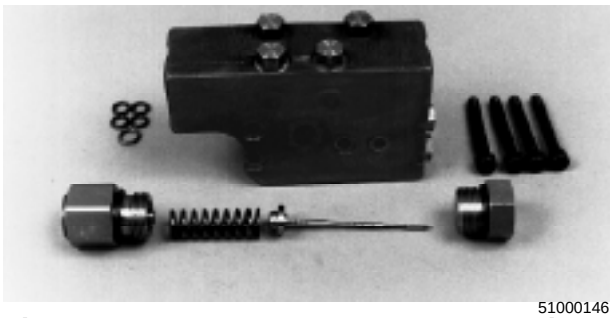
51000146

Fig. 50-130 - Pressure Compensator Valve Block Components

Minor Repair and Replacement - Variable Motor (Continued)

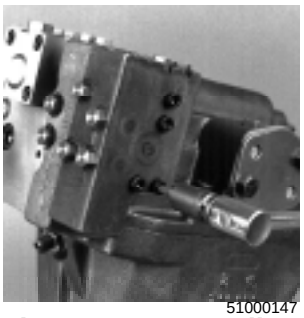
51000147

Fig. 50-131 - Install PCOR•PC Valve Block

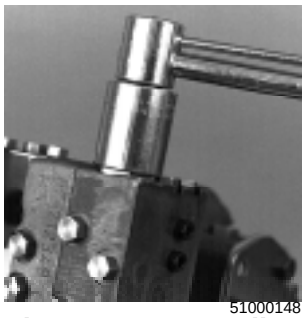
51000148

Fig. 50-132 - Install PCOR•PC Valve Plug

Install the valve block on the multi-function block and install the screws. Torque the screws to 11 Nm (8 ft•lbsf).

Install the valve block plug and torque to 54 Nm (40 ft•lbsf).

51000143

Fig. 50-133 - Install PCOR•PC Spring and Spool Valve

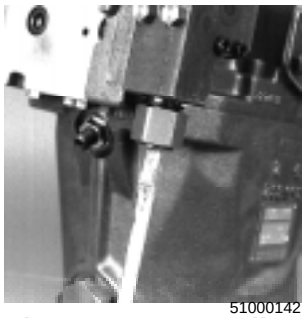
51000142

Fig. 50-134 - Install PCOR•PC Adjusting Screw

Install the pressure compensator spool assembly and the valve spring.

Install the adjusting screw and lock nut. Perform the PCOR or PC regulator pressure adjustment as described under “Component Adjustment."

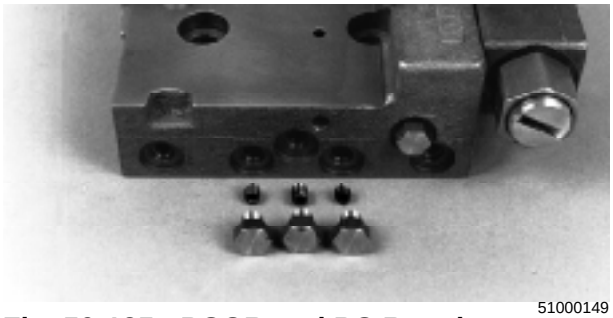
51000149

Fig. 50-135 - PCOR and PC Regulator Orifices

PCOR and PC Regulator Orifices

To gain access to the PCOR or PC regulator orifices, remove the three (3) plugs located between the defeat spool stop plugs on the multi-function block, using a 7/16" hex wrench. Remove the PCOR brake pressure defeat spool (if installed). Remove the orifice plug(s) and plain plug(s) with a 2.5 mm internal hex wrench.

Refer to the appropriate Service Parts Manual for information on orifice locations and sizes.

Install the orifice plug(s) and plain plug(s), and torque to 4 Nm (35 in•lbsf). Install the outer plugs and torque to 6 Nm (4 ft•lbsf). Reinstall the PCOR defeat spool (if removed).

Additional orifices are installed in the passages under the pressure compensator valve block.

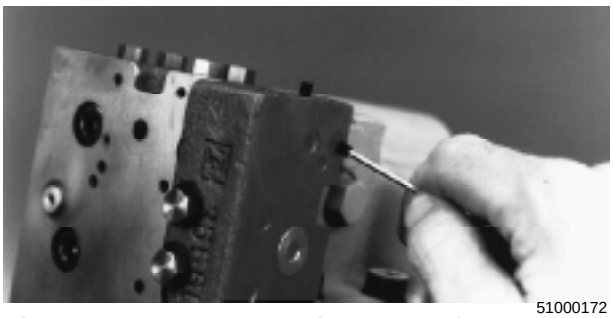
51000172

Fig. 50-136 - PCOR and PC Regulator Orifices

Minor Repair and Replacement - Variable Motor (Continued)

PCOR Brake Pressure Defeat Spool

Remove the PCOR defeat spool bore plugs or fittings with a hex wrench.

Remove the PCOR defeat spool stop plugs with a 7/16" hex wrench. Remove the defeat spool.

NOTE: The defeat spool may be removed from either end of its bore in the multi-function block.

51000150

Fig. 50-137 - Remove PCOR Defeat Spool Plug or Fitting

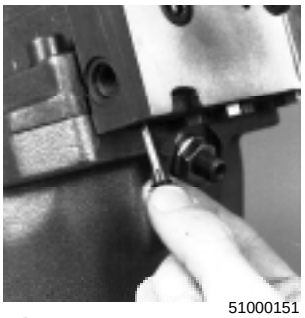
51000151

Fig. 50-138 - Remove PCOR Defeat Spool Stop Plug

Inspect the defeat spool for burrs or roughness. The spool must slide freely in its bore. Inspect the pins in the stop plugs for damage.

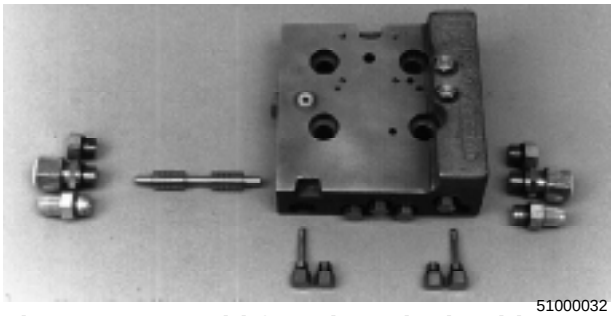
51000032

Fig. 50-139 - Multi-function Block With PCOR Defeat Spool Components

Install the PCOR defeat spool into its bore in the multi-function block.

Install the spool stop plugs into the multi-function block. Torque the stop plugs to 6 Nm (4 ft•lbsf).

Install the defeat spool bore plugs or fittings and torque to 27 Nm (20 ft•lbsf).

51000152

Fig. 50-140 - Install PCOR Defeat Spool

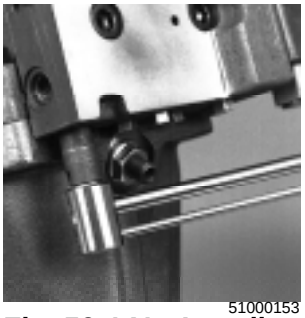
51000153

Fig. 50-141 - Install PCOR Defeat Spool Stop Plug

Minor Repair and Replacement - Variable Motor (Continued)

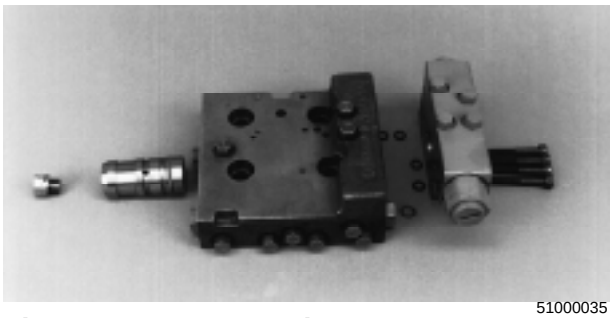

Fig. 50-142 - PC Regulator Components

Pressure Compensator Regulator (Type PC)

The PC regulator utilizes the multi-function block and pressure compensator valve to control the motor displacement.

Service procedures for these components are included in the “Multi-function Block” section of this manual.

Fig. 50-143 - Remove Valve Sleeve Bore Plug

Fig. 50-144 - Servo Drain Orifice (T7)

A valve sleeve bore plug is installed in the motor end cap in place of the valve spool sleeve. Remove the plug from the valve sleeve bore in the end cap. (An 8 mm threaded hole is provided in the plug for a puller screw.) Remove the O-ring from the plug.

A single servo drain orifice is installed in the valve sleeve bore plug. This orifice limits oil flow from the maximum displacement end of the servo piston to the motor case.

Install a new O-ring on the valve sleeve bore plug. Install the bore plug into the end cap.

The special plug and seal washer on the end cap opposite the multi-function block may be removed with a 13 mm hex wrench. When installing, torque this plug to 20 Nm (15 ft•lbsf).

Minor Repair and Replacement - Variable Motor (Continued)

Control Orifices

Orifices are installed in the motor end cap to regulate oil flow to the servo control valve and the servo piston.

To gain access to these orifice plugs, remove the three (3) plugs located on the motor end cap nearest the multi-function block or control, using a 7⁄16" or 9⁄16" hex wrench. Remove the orifice plugs (plain plugs for N2 control) with a 3 mm internal hex wrench.

Install the orifice plugs, and torque to 4 Nm (35 in•lbsf). Torque the 5⁄16" outer plugs to 9 Nm (7 ft•lbsf), and the 9⁄16" outer plug to 37 Nm (27 ft•lbsf).

Orifices are also installed in the servo control valve sleeve to control oil flow from the servo piston to the motor case.

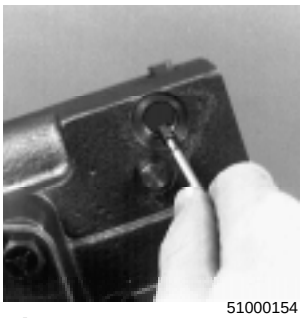

Fig. 50-145 - Servo Pressure Supply Orifice (T1)

Fig. 50-146 - Servo Orifice for Maximum Displacement (T2)

Fig. 50-147 - Servo Orifice for Minimum Displacement (T3)

Fig. 50-148 - Servo Drain Orifices (T7 and T8)

Plug / Fitting Torques

If any plugs or fittings are removed from the unit during servicing, they should be torqued as indicated in the accompanying table.

Item	Torque
Pressure Gauge Ports (9/16—18 O-Ring Hex)	37 Nm (27 ft•lbsf)
Construction Plugs (9/16—18 O-Ring Int. Hex)	20 Nm (15 ft•lbsf)
Construction Plugs (5/16—24 O-Ring)	9 Nm (7 ft•lbsf)
Screw Plugs (M6 Int. Hex)	4 Nm (35 in•lbsf)

Notes

Notes

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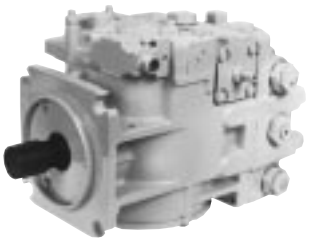
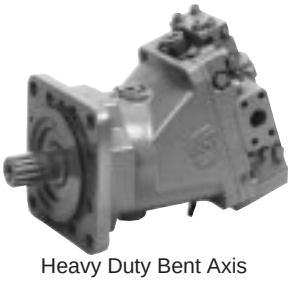
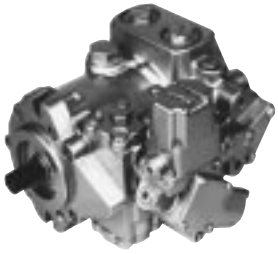


Heavy Duty Axial Piston Pumps and Motors

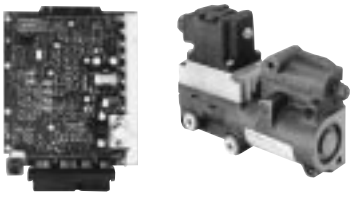


Heavy Duty Bent Axis Variable Motors

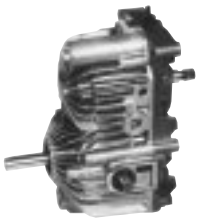
Cartridge Motors/ Compact Wheel Drives



Medium Duty Axial Piston Pumps and Motors

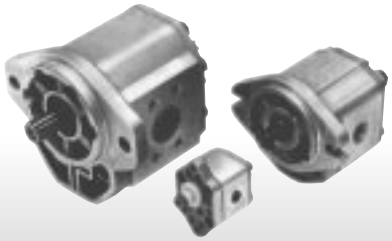


Microcontrollers and Electrohydraulic Controls



Hydrostatic Transmission Packages

Open Circuit Axial Piston Pumps



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